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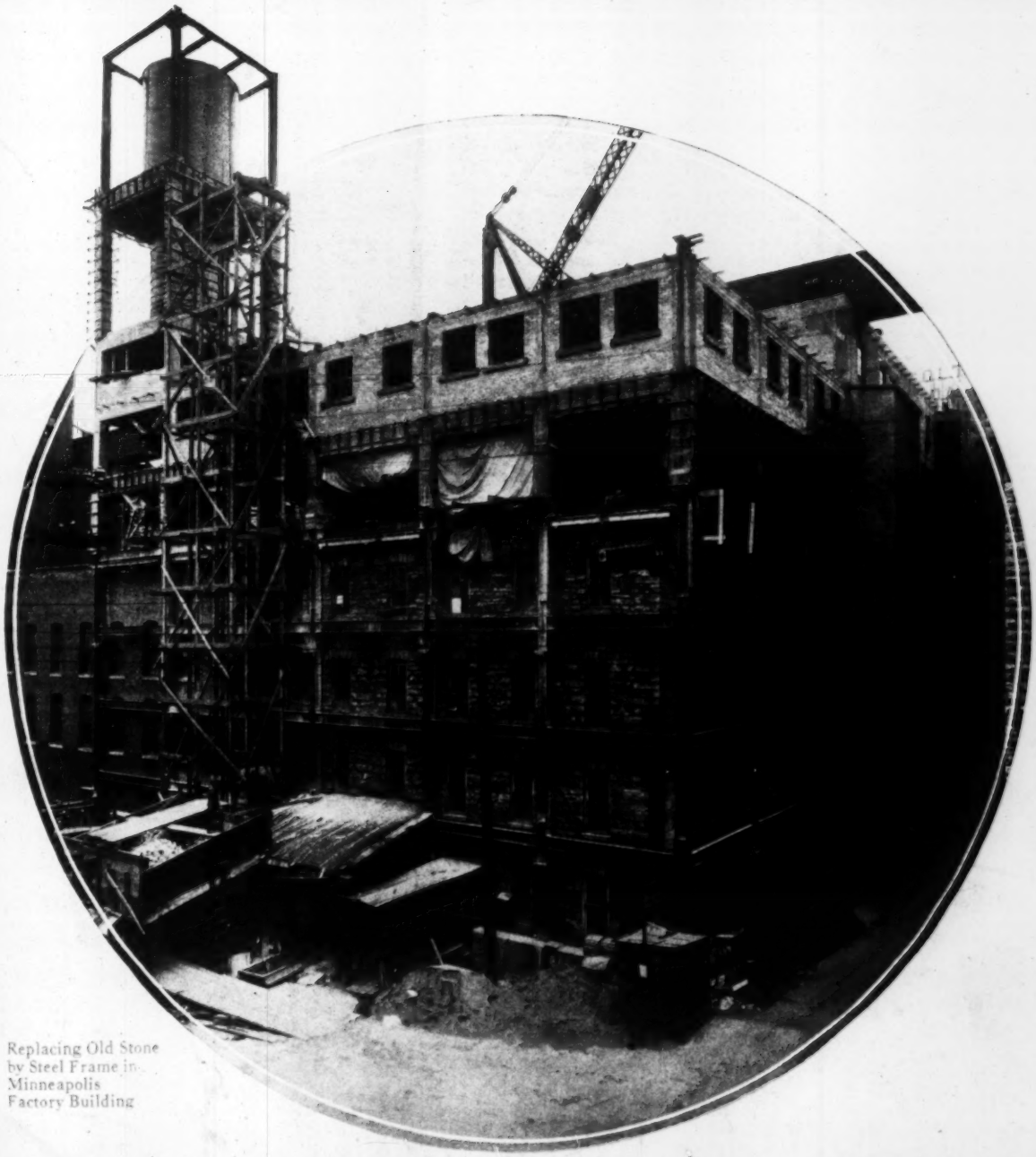

Replacing Old Stone by Steel Frame in Minneapolis Factory Building

Shore Protection Lessons of the Florida Hurricane, by R. M. Miller—Old Stone and Wood Mill Replaced by Substitution, by C. F. Haglin—Protecting Oil Reservoirs Against Lightning, by Marion E. Dice—Abstracts of A. S. T. M. Convention Papers

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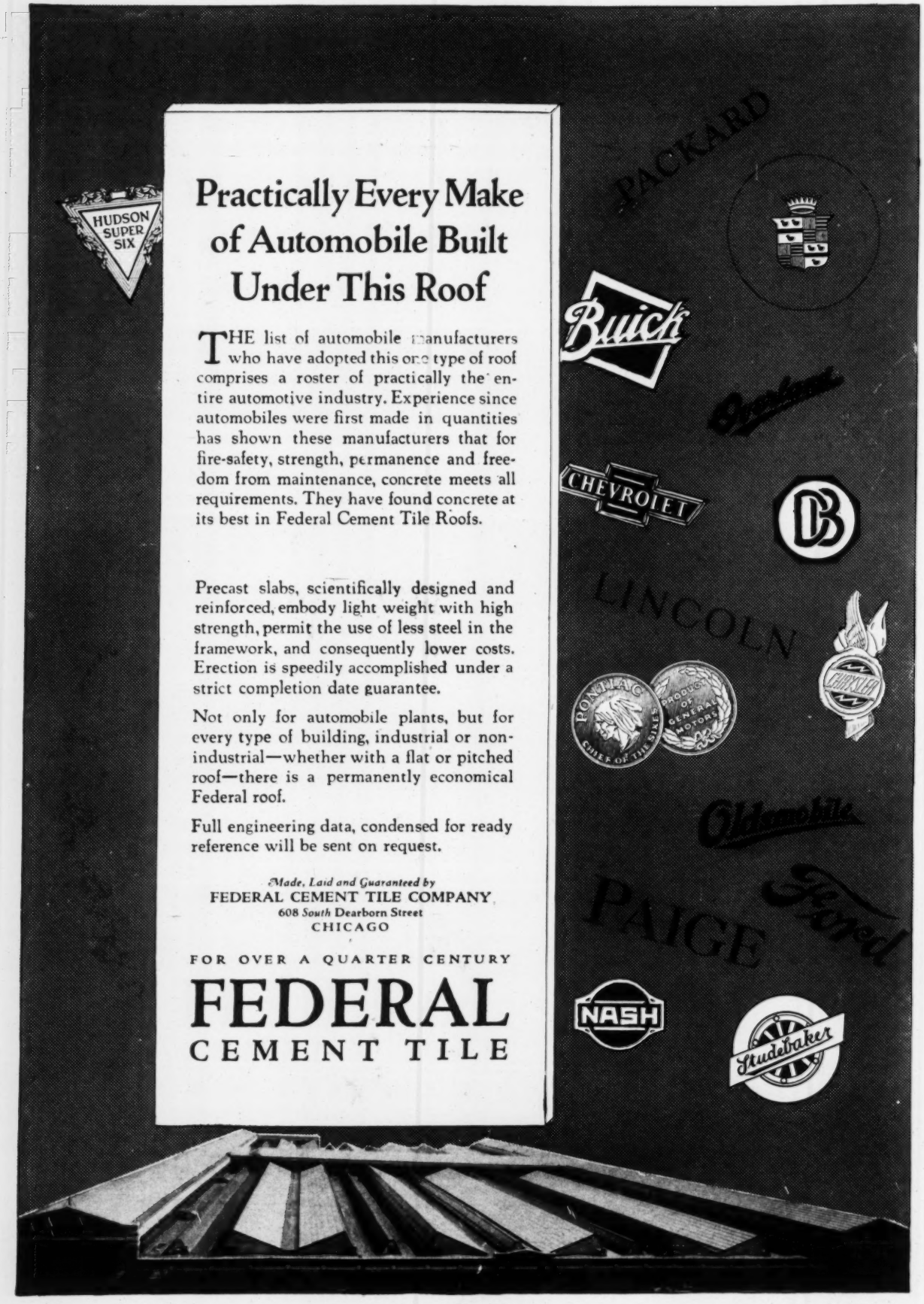

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
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FRANK C. WIGHT
Editor

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Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally, to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by Frank C. Wight, Jan. 1, 1924.

The staff of *Engineering News-Record* consists of—

New York: Frank C. Wight, *Editor;* M. N. Baker, F. E. Schmitt, C. S. Hill, J. W. Shaver, V. T. Boughton and W. G. Bowman.

Chicago: E. E. R. Tratman, W. W. DeBerard *(on leave of absence)*.

San Francisco: N. A. Bowers.

Triumphs of the Air

FIRST one alone, then two, and now four skilled flyers, all within the compass of a few short weeks, have guided their planes eastward into the morning skies over Long Island and out over the Atlantic Ocean not to come down again until they reached the mainland of Europe. And while the four were flying eastward two others were flying westward over the Pacific Ocean to a safe landing in the Hawaiian Islands. Thus rapidly is history being made in the newest mode of human transportation, that of aviation. Not since the early months of the World War has flying been so stimulated as it has by these daring flights. The desire to fly is as old as human observation of birds on the wing, but the ability to do so, somewhat crudely as yet, has come only within the brief knowledge of most of us. Development of ability to fly over great distances skillfully and with reasonable assurance of safety is now at hand. Evidence of this is the great contribution of the recent flights. Aside from their spiritual value in lifting us all out of the humdrum of our daily lives for the moment, they give definite assurance that man has at hand motors whose endurance and instruments whose precision bring long-distance flying close to the realm of everyday practicability.

Expanding the A. R. B. A.

A PROMISE of progress in highway association work is contained in the organization a fortnight ago of the County Highway Officials Association as a division of the American Road Builders Association. With the advanced development since 1916 of the primary system of state roads there has been increasing need of corresponding improvement of the secondary system of county roads. In an imperfect way this improvement has actually gone ahead. In well known individual instances county road systems have been developed with foresight, enterprise and technical skill equaling anything shown in the best examples of state road system administration. At the highest count, however, these notable county road system developments are comparatively few in the total of over three thousand county road systems in the country. From the peak of development in these few counties the curve of accomplishment and efficiency drops down through many grades of capable and mediocre management to the low point of almost complete inefficiency and lack of funds. Gradation of improvement is of course to be expected. The disturbing observation is that in many cases low grade is due to incapable management and not to want of funds or to lack of traffic demand for better roads. Other counties and often neighboring counties, with as little money and as moderate traffic, have superior roads. It is here that capable association work can be made to count, first by driving home the fact that trained direction is paramount and second by providing for interchange of knowledge and experience. To organize for effective work a division of 3,070 persons (a delegate from every county is planned) calls for more than the cursory attention of voluntary workers. There should be paid direction of the new division. The American Road Builders Association fortunately has the money to spend. It can better put it to this use than to most uses to which it has so far been proposed to put it. The county road officials division of the A. R. B. A. deserves a better fate than to remain a lofty gesture.

Lightning and Oil Fires

SINCE the disastrous oil-reservoir fires last year, in which many millions of dollars were lost, oil companies have been working energetically to develop effective lightning protection for stored oil. Until the fires occurred the seriousness of the spark menace had not been appreciated—the danger had increased unnoticed as oil reservoirs were made larger and larger and then, with dramatic suddenness, the great fires awakened the oil industry to a new problem. Protection against lightning involves many elements of which a comprehensive analysis can be made only by the electrical engineer. The problem is primarily his. However, when danger of fire is considered so great that insurance can be secured on only a small part of the oil stored in great

reservoirs, the civil engineer who builds those reservoirs is directly concerned. This concern has brought results. Spurred to action by last year's catastrophes, in a remarkably short time the large oil-storage "farms" have been put in a far safer condition with respect to the lightning menace. This has been done, not through the application of any one scheme or device, but by a full recognition of the seriousness of the electric spark danger and by making a very thorough and systematic application of preventive measures. Elsewhere in this issue, Marion E. Dice, engineer of tests for the General Petroleum Corporation, reviews ways and means that have been employed by several large oil companies of California in effecting this notable improvement in the oil-fire hazard. While known hazards have been corrected in a thorough manner, research has been undertaken to develop more information about the nature of lightning discharge and the attending electrical conditions. Laboratory work of great value in the study is being carried on by the General Electric Co. at Pittsfield, by California Institute of Technology at Pasadena and by Stanford University at Palo Alto and the large oil companies are all supplementing this research in their own testing departments. The investigation is not wholly confined to laboratories; a fund has been subscribed by several oil companies for a full-scale field test at Carson Spur, near Lake Tahoe, where electric storms are frequent in certain seasons. Here full-size steel towers are to be erected and equipped with instruments of various kinds and trained observers will study and analyze the phenomena of electrical discharge from clouds. There is much research yet to be done and doubtless there will be many improvements in the present protective methods, but in the main the problem is well in hand and the industry has reasonable assurance that there will be no repetition of the great disasters of last year.

Timber-Frame Building Construction

PERHAPS few engineers outside of those engaged directly in the design and construction of industrial buildings realize the extent to which heavy timber frame construction is being used for large warehouses and manufacturing buildings, in active competition with both concrete and steel. Some recent examples of this type of timber construction are described on another page. Mention of timber construction may at once suggest a fire hazard. But as a matter of fact, structures of this class have a good fire record, while owing to their slow-burning properties they are regarded favorably by fire protection and fire insurance interests. This is especially the case when sprinkler systems are installed, since the fire hazard is likely to be determined by the contents or occupancy of a building, rather than by the type of building construction. Timber buildings have naturally a higher rate of depreciation than steel or concrete, but industrial buildings of this class rarely wear out. Their removal or reconstruction is determined by obsolescence rather than by structural life, owing to developments in building construction and to changes in the occupancy of different sections of a city. Low cost and rapid erection are the main factors in the selection of timber framing, as compared with concrete or steel, and when steel is used it usually involves the expense of being cased in fireproof material to meet the requirements of local building codes. In general, for the cost of similar structures all complete, timber construction appears to rank from 15 to 25 per cent lower than the other materials. On the other hand, modern methods are reducing the cost of concreting, while it is reported that in some cases the increasing cost of structural timbers of large size is reducing their comparative economy. Then again, the height of timber frame structures is restricted by building codes and other regulations. In spite of all this, timber construction finds a wide field, and it is evident that it is an important and active factor in industrial developments.

Finish, Not Finishing

TAMPING, jobbing, rodding, spading and other methods of agitation have been so long regarded in concrete construction as processes which could hardly be carried too far, that recent road slab specifications strictly limiting the working and finishing of the concrete seem like the interrogation of inviolable dogma. Only a few years ago roadbuilders pointed with pride to the number of things they did to the top of a concrete pavement as assurance of a fine finish. Now they are viewing with alarm any procedure leading to refinement of surfacing beyond that necessary to give true planeness to the finished road. As for the old practice of floating the "soup" of fine material and excess water over the slab top as a sort of paint coat, it is anathema. There must be a "dry" top after finishing; that is, there must nowhere appear the glaze of excess water in glancing from any position slantingly over the slab. In its newest instructions, the Pennsylvania highway department requires that "the amount of finishing and manipulation of the surface shall be reduced to a minimum," and wherever a flotation of thin soupy material is flushed to the surface it "shall be removed from the pavement and not worked over the concrete surface." Illinois for a year or two has held to the same requirements and is insisting constantly more strongly on their observance. Other states are studying aggregates and consistencies which will give true surfaces with the least finishing. Any further census is not important at the moment. The fact to be noted is that with no less demand by highway engineers for road slab finish they are discouraging its attainment by excessive manipulation and a multiplicity of surfacing processes. Finish, in brief, in its new meaning is a true surface of homogeneous texture and not a surface polished through repeated rolling, belting and troweling. The reason is that it is being found that the skin coating of polish is scaling off and making the roads look badly. The new standard of finish is considerably harder to attain than the old and contractors will do well to keep the fact in mind when considering work where this standard prevails.

Wheels of Progress

SLIDING forms were used for the construction of a group of grain silos recently completed in England. In commenting upon the advantages of the method, *Engineering* (London) says: "This ingenious method has been widely used in the United States, but has hitherto been almost unknown in this country. We believe this to be the first example of its use, at all events, on any large scale." In view of the wide variety of uses to which sliding forms have been put in this country, it is of interest to note that English engineers and contractors, who have to work under quite different conditions, are finding them of value.

Why There Is Too Much Oil

MORE often than not the oil industry is suffering from one thing or another. At the present time it is too much oil, the daily average production hovering around 2½ million barrels, which is some 300,000 bbl. over daily requirements. Although many columns of newsprint are being devoted both to analyses of and speculation on the situation in general and Seminole in particular, so far one very important phase of the present boom has been insufficiently stressed if it has been mentioned at all. This is the fact that the present flood of oil from Seminole is a direct result of modern engineering methods of oil production while all former boom fields have been maintained at a high production peak only as a result of natural forces within the earth.

With the exception of the slight and not common effect of hydrostatic pressure, oil flows from the ground solely by virtue of the pressure of the natural gas trapped in the dome and of that mixed with the oil itself. Such gushing fields as Smackover, Cushing, and most of the present Texas Panhandle have been in areas of high gas pressure. Seminole, on the other hand, has a very low gas pressure and consequently the natural flow of oil is small; in fact, the now prolific area was passed over several years ago as not worthy of extensive development. Indeed under the old conditions of pumping at the then common well depth of 1,500 ft., the field probably would have been of minor consequence.

But consider the present situation. Some one brought a rotary drill into the field and penetrated a stratum known as the Wilcox sand at a depth of 4,000 ft. The oil flow was prodigiously increased and the application of a modern engineering method in the form of deep drilling was directly responsible. When the flow rapidly diminished as the gas pressure was spent, there was introduced a second engineering method—the air-gas lift and the most important single factor in Seminole's production of 400,000 bbl. of oil per day.

The air lift, the gas lift and the air-gas lift as it is variously called, depending upon the lifting medium, was first patented in the United States some 40 years ago. For use in flowing oil wells, however, it is of more recent application. Some success attended its use around Los Angeles in 1925 and later in the same year the production of the Tonkawa, Okla., field was increased by air-gas flowing. Seminole, however, represents the first extensive use of the system.

In principle, these air-gas lifts are not different from the air lifts used on water-works plants, in both cases the work performed by a gas in expanding from a given pressure to atmospheric being used to lift the liquid column from the well. In practice, however, enough differences are encountered to make oil-well flowing much the more difficult. The effect of the gas which is mixed with all oil must be eliminated in computing submergence; the submergence for a given pressure is greater on account of the lower specific gravity of oil; wells are deeper and the lift is therefore higher; quantities and pressures of the air introduced must be more carefully computed and controlled because of the already present gas in the oil; required air pressures are usually higher; and finally the necessary conservation of the gas in order to remove its gasoline content and to recharge the well and surrounding sands requires the use of more equipment and more efficient methods. All these are every-day problems of the engineers at Seminole and although much is yet to be desired in the way of efficiencies, more oil is being produced by the air-gas lift than could be by any other available method.

Deep drilling and air-gas flowing are the factors that account for Seminole's remarkable production. But despite the present gratifying results, much is augured for the future of air-gas flowing. It has in fact been proposed that oil conservation could be furthered and the evils of overproduction consequently reduced by placing some legal limit upon the amount of gas that would be allowed to escape from oil wells. It is doubtful if any such restriction would work in the highly competitive oil industry even if the physics of the method were consistent. But it is not beyond the realm of possibility that some method can be developed whereby oil conservation can be placed on an engineering basis similar to that which oil production is approaching. It is indeed to such a basis that the oil industry must anchor its co-operative panacea at present so illusive. In the meantime we may be quite sure that the use of deep drilling, air-gas flowing and other engineering methods will increase our ultimate recovery considerably over the 15 to 30 per cent of the oil in the sands with which we have heretofore had to be satisfied.

A Notable Test Road

THE California highway described in this issue is notable as the longest test road ever built. More significantly, it has been built for a natural traffic test. The various Arlington farm tests of the Bureau of Public Roads, the Bates road tests in Illinois and the Pittsburg road tests in California have all been accelerated tests. Notable as have been the results of the work done in these three great tests, it has always been open to question whether they gave a true indication of actual traffic effects over periods of years instead of periods of days or weeks. Certainly they can have reflected only very dimly the effects of time and the elements: the contraction, expansion and warping as the temperature changes daily and seasonly, the heaving and disruptive action of frost, the washing and drift of dirt by rain and wind to supply abrasives to the spinning automobile wheels—all constantly repeated year after year—all were largely lacking at Arlington and on the Bates and Pittsburg roads.

The contrary will be the case on the new California test road. This will afford a real service test not only of vehicle impact and wear, but of the compound of vehicle action and the exactions of nature's elements which the commercial road has to endure. The detail of arrangement and makeup of the test sections do not require repetition beyond noting that exceptional pains have been taken to ensure average behavior by getting readings on two identical sections differently located. Unlike the accelerated tests previously undertaken, the natural traffic tests of the California road may not be expected to give immediate definite information. The accumulation of data will be progressive over years of time and in great degree the usefulness of these data will depend on regular and uniformly recorded observation. This involves a set-up by the highway commission which will assure such observation. The California road officials who have put highway engineering in their debt by providing so magnificent an opportunity for experimental study should keep this debt alive by continuous recording and analysis.

One of a Series of Articles on
OIL FIELD ENGINEERING

Protecting Oil Reservoirs Against Lightning

Spark Menace Greatly Reduced in California Fields in Past Year—A Review of Methods Used by the Larger Oil Companies in the West Coast Field

By Marion E. Dice
Department of Tests, General Petroleum Corporation of California, Los Angeles, Calif.

DURING April, 1926, lightning caused the destruction of nine million barrels of oil storage facilities in California, with an economic loss second in the history of the state only to that of the San Francisco disaster of 1906. The catastrophe awakened the petroleum industry to the hazards of above-ground storage and set in motion a number of engineering activities which have led to the general adoption of protective measures throughout the state. This article is intended to report a survey of methods and to describe the present state of the art of lightning protection as practiced in California.

The earliest oil reservoirs were made of earth. They were satisfactory for heavy, viscous oils and many are still in use in the Kern River field. Later pools produced light oils which, because of seepage losses, made concrete lining necessary. Most of the reservoirs built since 1914 have been concrete lined.

They vary in size from a circular container 300 ft. in diameter, with a capacity of 225,000 bbl., to a huge oval 500 by 1,425 ft., with a capacity of more than 4,000,000 bbl. The depth of oil, when full, is from 20 to 41 ft., usually between 25 and 30 ft. The earth excavated from the central portion is piled up to form a dike, and after rolling and packing, the structure is lined with road oil or reinforced concrete. The floor is nearly flat and the sides fairly steep, with a slope of 1 to 1 up to 2½ to 1.

The roof is made of wood, supported on wooden posts and covered with asphalt-saturated felt roofing compounds of various kinds held in place by metal nailing strips and nails. When in use, the space between the oil and the roof becomes filled with a mixture of air and oil vapors whose composition varies with the character of the oil and the temperature. Crude oils of high gravity are the most dangerous product stored. The vapors over refined fuel oil are never explosive and those over heavy crudes rarely so.

Reservoirs are often placed in groups called farms. They are spaced safe distances apart and separated by fire walls or dikes designed to impound more than the capacity of the reservoir in case of a break or boilover.

California Reservoirs and Their Contents—California has 37 per cent of the earthen storage, 98 per cent of the concrete storage, and 66 per cent of the total reservoir storage in the United States. The total capacity of oil reservoirs in California and in the United States, according to a recent survey by the Bureau of Mines, is:

	California Bbl.	United States Bbl.
Earthen reservoirs	29,802,000	80,500,000
Concrete reservoirs	71,412,000	72,661,000
Total	101,214,000	153,161,000

Reducing Spark Hazards—Among the steps taken to reduce reservoir fire hazards as a result of experience in the 1926 fires and experimental work which followed, are (1) the elimination of explosive mixtures above the oil, (2) the elimination of water from reservoir bottoms, and (3) the installation of lightning protection systems.

The elimination of explosive vapors has been accomplished in most cases by refining the crude and returning only the fuel oil to reservoir storage. Gasoline and other light fractions are stored in steel tanks. In nearly all cases where light crude remains in reservoirs, inert gas systems have been installed. These will be discussed later.

Experience has shown that the presence of water in a reservoir, either emulsified or free, usually causes boilovers when the reservoir burns, spreads the fire over surrounding areas, and endangers other structures. Boilovers in 1926 caused nearly as much damage as the initial lightning strokes. Therefore the practice of sealing the bottoms with water (to prevent oil leaks) has been discontinued. Reservoirs have been drained, cleaned, and placed in refined oil service wherever possible. No wet oil is pumped into them. In case of fire, it will now be much easier to confine it to its source.

The past year has also brought changes in steel tank construction. Wooden roofs, long known to be leaky and hazardous, are rapidly being replaced by floating roofs or all-steel gas-tight roofs with modern screened vents and flame-proof equipment. The floating roof has come into more favor with improvements in design and mechanical features. If properly designed, it offers advantages over other types of roof in that it eliminates the dangerous vapor space and reduces evaporation losses.

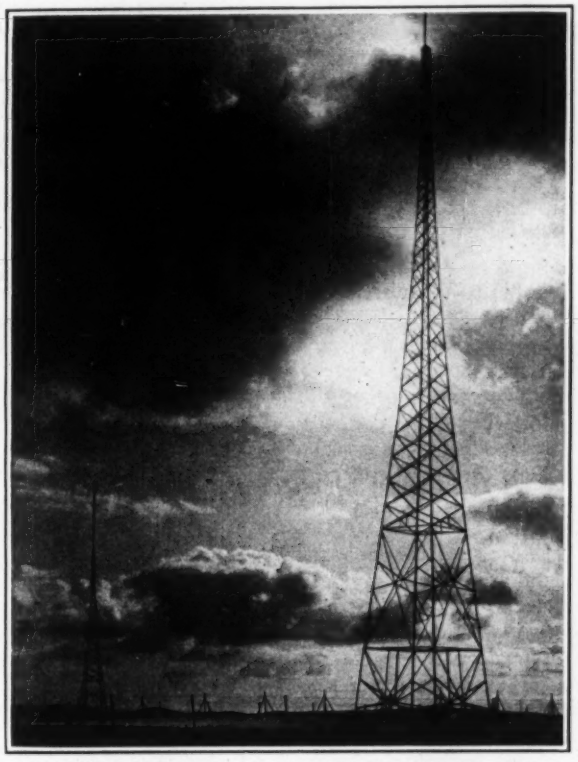
Most of the oil now stored in reservoirs is refined fuel and low-gravity crude. Only 12 per cent is crude capable of giving explosive vapors, and this is further protected in most cases by inert gas systems. The capacities of reservoirs used for various grades of oil are given in the accompanying table. Note that the figures are total capacities and not the actual quantities of oil in storage. These figures and those of Table I include 95,950,000 bbl. owned by seven companies out of a total of 101,214,000 bbl. in the state.

Kind of Oil	Storage Capacity, Bbl.	Per Cent of Total
Fuel, less than 20 deg. A.P.I.	57,900,000	60
Crude, less than 20 deg. A.P.I.	26,800,000	28
Crude, more than 20 deg. A.P.I.	11,250,000	12
Total	95,950,000	100

Inert Gas Systems—The only reservoirs in which explosive vapors collect above the oil are those containing crude oil of relatively high gravity and large gasoline content. The vapors above refined fuel oil, residuum,

and most heavy crudes are non-inflammable. At the present time only twelve reservoirs, with a total capacity of 11,250,000 bbl., are used for light crudes whose vapors are likely to be inflammable. All except two of these reservoirs have inert gas systems which supply flue gas to the vapor space in lieu of air and thereby keep the oxygen content of the vapors below 6 per cent.

Flue gas is taken from the breechings of nearby refinery boilers, cooled, scrubbed, and pumped to a breather vault near the reservoirs. A constant supply of gas is pumped to the vault and allowed to escape through an atmospheric relief. Each reservoir is connected to the breather vault by a pipe line. All reservoir breathing is through this vault, with a slight pressure (0.2 in. of water) maintained in the vapor space to prevent air from entering through roof leaks.



LIGHTNING TOWERS AROUND 750,000-BBL. RESERVOIR
Grounded wire network is here used close to reservoir roofs. Note earth dikes to deflect streams of overflowing oil.

Most of the reservoir owners have taken gas samples from the vapor space of each reservoir and tested them for hydrocarbons, oxygen, and inflammability. Some make these tests at regular intervals. All are satisfied that the vapor space in every reservoir contains non-inflammable gas.

Lightning Protection Systems—Three methods of protection against lightning are in use: (1) towers which function as lighting rods, (2) networks to prevent sparks caused by induced discharges, and (3) barbed wire designed to discharge the thundercloud sufficiently to prevent dangerous voltages.

A summary of the number of barrels of reservoir storage protected by various means by the major operating companies is given in Table I, which lists 95 per cent of the storage in the state. The remaining 5 per cent is probably in isolated locations and unprotected.

In addition to the reservoir protection listed in Table I, the Associated Oil Co. has installed towers and networks to protect 286,000 bbl. of steel tankage with wooden roofs. All-steel gas-tight tanks are believed from experience to be able to carry direct strokes safely.

Table I shows 25,300,000 bbl. of storage without protection. Most of these reservoirs are small and in isolated locations far from populous centers and are used only for heavy oil. Protection will probably be installed for some of them before the next thunderstorm season. Some of these reservoirs are emergency containers made by throwing an earth dam across a canyon in rolling country, with no floor covering and no roof. They are used for heavy oil containing much sand.

Dimensions and Locations of Towers—The towers are usually of steel lattice construction of the type used for radio antenna supports. They are from 75 to 200 ft. high. The base is from 4 to 24 ft. square, resting on concrete footings. The upper portion of the tower is usually a piece of pipe, with various kinds of pointed tips.

In some cases the towers are connected by cables fastened to the lattice work below the pipe extensions. One company grounds the center of each cable span by a copper down-lead, and places a 7-ft. copper rod at the junction of the cable and the down-lead, with 3 ft. of its length projecting above the cable. This is intended to localize corona and, by forming an ionized path, aid in directing the stroke to the system.

Most of the towers were located in accordance with the experimental findings of F. W. Peek, Jr., of the Pittsburgh laboratories of the General Electric Co. ("Lightning; a Study of Lightning Rods and Cages, with Special Reference to the Protection of Oil Tanks," *Jour.* A.I.E.E., 45, 1246, Dec., 1926). He originally proposed an empirical law that a lightning rod would protect a radius equal to four times its height, and five companies built towers on this basis. Later laboratory work, however, brought about a modification of the law and led to an increase in the height of many towers. One company has increased the height of its towers from

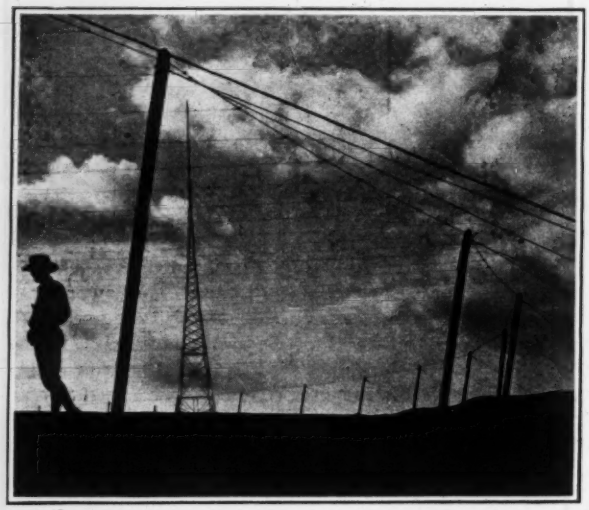
TABLE I—LIGHTNING PROTECTION STATUS OF 95,950,000 BBL. OF OIL STORAGE IN CALIFORNIA

Owner	No. of Reservoirs Owned	No. of Reservoirs Protected	Storage Capacity in Barrels (42 U. S. Gallons) Without Lightning Protection	With Towers Exclusively	With Towers and Network	With Towers and Flue Gas	With Barbed Wire Supported On Towers	Total
Standard Oil Co. of Calif.	57	14	22,000,000	20,900,000	.....	.....	.....	42,900,000
Pan American Petroleum Co.	6	6	.....	.....	.....	.....	12,500,000	12,500,000
General Petroleum Corp. of Calif.	10	8	3,300,000	8,000,000	.....	.....	.....	11,300,000
Shell Co. of Calif.	10	10	.....	.....	11,000,000	11,000,000	.....	11,000,000
Associated Oil Co.	12	12	.....	.....	8,000,000	.....	.....	8,000,000
Union Oil Co. of Calif.	10	10	.....	.....	7,250,000	3,750,000	.....	7,250,000
Southern Pacific Co.	1	1	.....	3,000,000	.....	.....	.....	3,000,000
Totals	106	61	25,300,000	31,900,000	26,250,000	14,750,000	12,500,000	.....
Grand Total	..	..	.....	.....	.....	.....	.....	95,950,000
Per cent of grand total	..	..	26	33	27	15	13	100

150 ft. to 200 ft. The new basis, shown in the accompanying chart, gives the protected radius (in terms of rod heights) as a function of the ratio between the cloud height and the rod height.

Most of the reservoir farm rod layouts were tested by means of scale models in the Pittsfield laboratories, and final installations were made on these results rather than on empirical data from ideal cases. A model of the Southern Pacific Co.'s 3,000,000-bbl. reservoir at Tracy was subjected to 2,300 discharges of artificial lightning without a single stroke to the reservoir.

The General Petroleum Corporation made an elaborate series of tests with models at the California Institute of Technology, through the co-operation of Prof. R. W. Sorensen, before drawing up its construction program.



THE SCHAEFFER SYSTEM OF GROUNDED NETWORK
Typical arrangement, using wood post supports with cables drawn taut to backstays. Tower in background.

The layouts adopted were tested again by Mr. Peek with results in close agreement with those of Pasadena.

The Pan American Petroleum Co. carried out its own laboratory work along somewhat different lines as mentioned later.

Thundercloud Heights—In order to use Mr. Peek's protective ratio chart, it is necessary to know the approximate cloud height. Weather Bureau observers have measured the altitude at which kites and pilot balloons disappeared into the bases of clouds on 5,500 occasions east of the Rocky Mountains. Thunderclouds were measured in 700 cases.

The lowest thundercloud base measured was 820 ft. above the earth. The altitude of maximum frequency was 3,120 ft. Only 6.3 per cent of the cloud bases were below 2,000 ft.; 69.6 per cent were between 2,000 and 6,000 ft.; and 24.1 per cent were above 6,000 ft.

The height of thundercloud bases varies inversely with the humidity of the rising air. Therefore, since the average humidity on the Pacific Coast is lower than in the Central and Eastern states, the range of altitudes given is too low for the Pacific Coast. Only in exceptional cases will thundercloud condensation occur below 2,000 ft. in California, and 1,000 ft. may be set as an absolute minimum.

Ground Connections—The importance of good ground connections is recognized by all companies. Two have drilled a well to permanent water at each tower. Another has wells at most towers and connects the others to pipe lines. Two use pipe grounds driven to moist soil or kept moist by water from within the pipes. Two make ground connections to pipe lines only. Most companies bond their lightning protection systems to several earth connections; to permanent water, to pipe lines, and in many cases to buried copper rings surrounding the reservoirs.

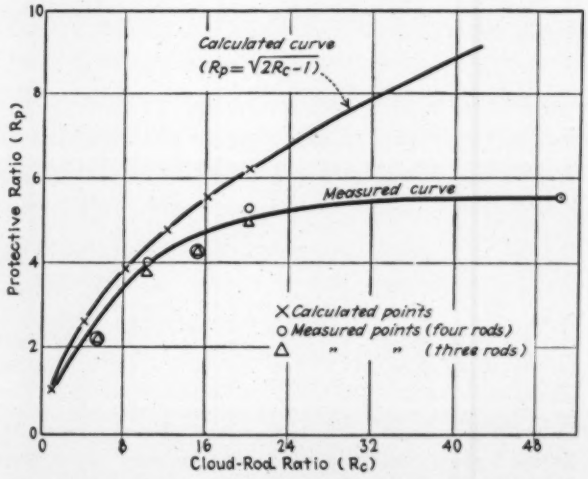
The General Petroleum Corporation connects each tower to permanent water through a well from 31 to 60 ft. deep. A No. 4 copper wire is used, being connected to each leg of the tower, to the pipe casing of the well, and to a weight hung below the water level in the pipe. The pipe is set in steel punchings to increase the area of metal in contact with water and earth. Each tower is also connected to the 3-in. water line surrounding the nearest reservoir. The water line is connected to the reinforcing mesh of the concrete by No. 4 wire at several points around the rim.

Where cables are used between towers, the center of each span is grounded (to decrease the inductance) by a $\frac{1}{8}$-in. flexible copper sash cord falling from the cable, anchored to a pipe post just outside the fire wall, and connected to the water line around the reservoir. This system provides metallic paths for ground charges from both their possible levels and the tower system, recognizing that the ground charge may reside at the level of permanent water or at the surface, depending on the conductivity of the earth.

Measurements of resistance indicate values less than 10 ohms through earth paths between separate wells or between wells and pipe lines, and less than one ohm through all metallic paths of the system.

Most companies have made no special provision for grounding the reinforcing steel of the reservoirs. The concrete floors are of such large area that good ground contact is assured. Many resistance measurements have been made between the mesh and nearby water pipes. So far as is known, none of the resistances exceeded 10 ohms; most of them were lower.

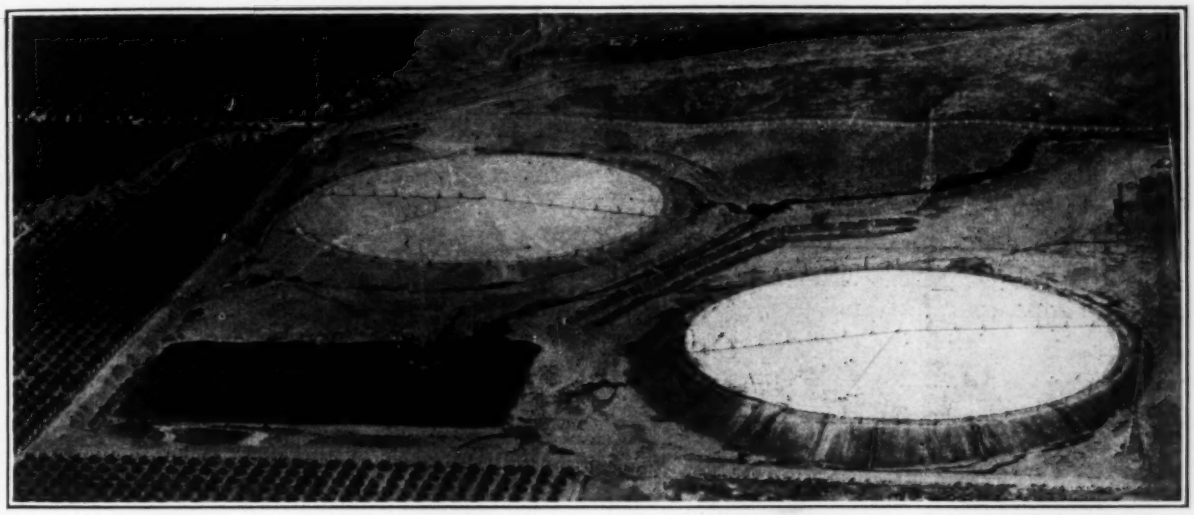
Network Protection—It is well known that fires may be started by lightning without occurrence of direct hits. A cloud-to-cloud discharge or a stroke to earth at some



CURVES SUMMARIZING MANY THOUSANDS OF LABORATORY TESTS
R_p is protective ratio or ratio of radius to rod height. R_c is the ratio of cloud height to rod height.

distance from an oil tank may cause sparks between isolated metal parts due to the release of the bound electrostatic charge.

For example, a thundercloud may have its charge gradually increased, by the breaking up of water drops falling through upward currents of air (Simpson, G. C., "On the Electricity of Rain and its Origin in Thunderstorms," *Phil. Trans.* Roy. Soc. A 209, 379, 1909. See also *Proc.* Roy. Soc. for April, 1927), or whatever process takes place, until the voltage approaches sparkover. During the charging-up period, a charge of opposite sign builds up by induction on the earth below. At sparkover, (whether to another cloud, to another part of the same cloud, or to earth) the induced charge on the earth is released. It spreads out in all directions to get back to normal density. Sparks can occur during this rush only between isolated conductors or conductors in poor contact. A reservoir roof may have isolated metallic structures such as gaging wells, swing-pipe winch boxes, ventilators, etc., or it may have a combination of metal nailing strips, nails, and patches of condensate below the roofs with dangerous spark gaps.



LOOKING DOWN ON A PROTECTED RESERVOIR FARM

These two 750,000-bbl. reservoirs were brought within the 4 to 1 protection ratio by the towers shown plus two 100-ft. poles.

All reservoir owners have inspected their reservoirs and have taken precautions against such conditions wherever possible. Metallic equipment and pipes have been interconnected and grounded. Roof structures well out from the edge have been grounded by No. 4 or No. 6 copper wires running down through the oil to the reinforcing mesh or over the reservoir bank to a water pipe.

Perfect protection against induced discharges may be obtained only by the use of all-metal roofs, with all joints well bonded. An approximation to an all-metal roof may be secured by the use of wire mesh or networks.

A system developed by Dr. E. R. Schaeffer of Johns-Manville, Inc., has been adopted by three Pacific Coast companies. It has been placed on thirty-two reservoirs with a total capacity of 26,250,000 bbl. and on a number of wooden-roof steel tanks. This method uses the electrostatic shielding effect of a system of grounded wires suspended over the roof. It is a development of the Faraday cage, based on the equations of Maxwell and on laboratory and field tests extending over several years.

The network used on reservoir roofs consists of No. 12 galvanized telephone wires, parallel, spaced 4 ft. apart and 6 to 12 ft. above the roof. The wires are supported by a ⅜-in. peripheral cable carried on posts around the reservoir and by another cable crossing the roof on posts. Where the strength of the roof is not sufficient to carry the additional load, the center cable is suspended from a catenary. The network projects 16 ft. beyond the rim at all points.

The network used on wooden roofs of steel tanks consists of an umbrella type grid supported by a single post 9 ft. above the peak of the roof and by galvanized brackets spaced 15 ft. apart around the rim. No. 12 galvanized wires radiate from the center post to the brackets, with supplementary wires filling the wide gaps near the periphery so that the maximum spacing of wires is 5 ft.

On both reservoir and tank grids all wires are carefully bonded to the peripheral cable or tank brackets. The cables are grounded through their radial guys to water pipes or to a copper wire buried 12 in. and surrounding the reservoir.

The value of the network is due to the fact that it carries the induced charge, keeping it off the roof and affording good metallic paths to ground for its return after release. The percentage of the induced charge removed from the roof to the network is a function of the diameter and spacing of the wires, their height above the roof, and the cloud height. The arrangement adopted is one which is claimed to be an economical approximation of an all-metal roof.

Prevention of Lightning Voltages—One company has adopted a system which it is claimed will prevent the formation of lightning voltages and therefore prevent both direct and induced discharges. The system consists of barbed wire strung on steel towers 80 to 100 ft. high around each reservoir for the purpose of dissipating, by corona discharge, any induced charges in the area. The inventor, John M. Cage of Los Angeles, claims that the charge of a thundercloud may be neutralized in this

manner or kept below the sparking value. This system, which is described in detail in current petroleum journals (Wilcox, E. H., "Lightning Protection System Adopted to Prevent, not Guide, the Stroke," *Nat. Pet. News*, March 9, 1927, p. 77; same author, "The Cage System of Lightning Protection," *Oil Age*, March 1927, p. 18), has been installed on six reservoirs with a total capacity of 12,500,000 bbl. Included in this group is the largest oil reservoir in the world. The reservoirs are used for fuel oil only.

Evidence of Lightning Strokes—Four companies have adopted means of obtaining permanent evidence of direct strokes to tower systems, assuming that the towers themselves will not be damaged or even marked by a direct hit. The commonest procedure is to make the tip of the lightning rod of a low melting-point alloy so that it will be fused by a direct stroke. Various shapes of solid and hollow cones are used, and one company adds vanes on the cones so that their fusion may be easily detected with a field-glass.

One company is planning to equip each tower with a simple klydonograph, a photographic instrument which has recently come into prominence (Lee and Foust, "The Measurement of Surge Voltages on Transmission Lines Due to Lightning," *G. E. Rev.*, March, 1927, and *Jour.* A.I.E.E., 46, 149, Feb. 1927) for high-voltage surge detection and measurement. The method depends upon the formation of a characteristic figure on a photographic plate when a sudden change in voltage occurs between an electrode pressed against the emulsion and a metal plate on the other side of the glass. It is planned to connect the electrode to the tower and make no electrical connection to the plate. The electrode and plate will normally be at ground potential. A stroke of lightning to the tower will cause the potential of the electrode to rise suddenly above that of the plate, producing a figure.

Such records have added value in that they permit a deduction of the approximate voltage and wave shape of the discharge. No methods have been provided for obtaining evidence of the functioning of grounded networks under conditions which might produce sparks in unprotected reservoirs.

Table II is published through the courtesy of the Pacific Coast Steel Co., who designed, fabricated and erected all these towers except those for the last two companies listed. The towers are manufactured of special high-strength steel which has a minimum yield-point of 45,000 lb. per sq.in. and a 22 per cent elongation in 8 in., and is guaranteed to stand the flat bend test.

The use of this steel was especially advantageous in the erection of these high structures, as the very light sections which could be used, particularly at the tops of the towers, made their erection feasible with a minimum of rigging. The towers themselves were widely scattered; and located as they were, close to the oil reservoirs, it was often impossible to use power for hoisting owing to the fire hazard.

The small-base poles were designed for wind load only, the latticed portions were built in sections 25 ft. in length and made for total heights of 75, 100 and 125 ft. In erecting, the entire pole was assembled on the ground and lifted bodily into place.

The wide-base towers were designed for horizontal loads at the top of 1,500 lb. in addition to wind on the towers. Most of them, however, are not used in this way, but pipe extensions were later added to the tops as noted. These wide-base towers all have foundations consisting of four concrete piers at the corners. Foundations for the 3x3-ft. latticed steel poles consist of a single concrete block 4 ft. 2 in. square and 7 ft. deep. All towers and poles were thoroughly galvanized by the hot dip process after fabrication, and galvanized bolts were used for erection.

TABLE II—LIGHTNING PROTECTION TOWERS FOR CALIFORNIA OIL RESERVOIRS

Company	Date of Installation	Location	No. of Towers	Height*, Feet	Size at Ground, Ft.	Remarks
Shell Co. of Calif.	May, 1926	Martinez	3	150	23x23	
	May, 1926	Martinez	1	175	30x30	
	June, 1926	Watson	14	150	23x23	
Union Oil Co. of Calif.	July, 1926	Watson	8	150	23x23	Pipe extensions varying up to 50 ft. long added to these towers after erection.
	August, 1926	Santa Fe Springs	2	150	23x23	
	July, 1926	Stewart	6	150	23x23	
	August, 1926	Seguro	1	150	23x23	
	April, 1927	Stewart	3	75	3x3	Includes 25 ft. pipe extension.
	April, 1927	Stewart	3	100	3x3	
Associated Oil Co.	August, 1926	Coalinga	4	150	23x23	
	August, 1926	Seguro	14	150	23x23	
	August, 1926	Seguro	3	175	28x28	
	August, 1926	Huntington Beach	4	150	23x23	
	September, 1926	Avon	2	150	23x23	
	February, 1927	Avon	4	100	3x3	Includes 25-ft. pipe extension.
Southern Pacific Co.	August, 1926	Tracy	4	150	23x23	50 ft. pipe extension added afterward.
Standard Oil Co. of Calif.	January, 1927	El Segundo	48	100 to 175	3x3 to 5x5	20 to 50 ft. pipe extensions added afterward.
General Petroleum Corp. of Calif.	December, 1926 to March, 1927	Wilmington	12	180	24x24	20 ft. pipe extensions added afterward.
		Watson	6	180		
		Athens	8	180		
		Santa Fe Springs	4	180		
Pan American Petroleum Corp.	February, 1927	Watson	10	80 to 90	4x4	Barbed wire strung between towers.

*Heights are given as of time of erection.

Acknowledgment—Acknowledgment is made for much of the data of this article to Ralph J. Reed, Union Oil Co. of California, who also supplied several of the pictures; H. H. Hall, Standard Oil Co. of California; P. A. L. Engelbregt, Shell Co. of California; L. D. Jurs, Associated Oil Co.; E. H. Wilcox, Pan American Petroleum Co.; A. H. Babcock, Southern Pacific Co.; and S. J. Dickey, General Petroleum Corp., of California.

French Welded Girder

A welded girder of 28-ft. span and 20-in. depth used in remodeling a building in Paris, as described in *Le Genie Civil* of May 21, was designed with maximum shear of 3,700 lb. per sq.in. on the welds. It was built by welding two ½-in. flange plates, respectively 18 and 20 in. wide, on the top and bottom of a wide-flange 18-in. I-beam, by welded edge seams.

Five-Mile Concrete Test Road Built in California

A Different Design of Reinforcement and Joints Every 1,200 ft. on the Two Standard Slabs Employed in California

A TRAFFIC-TEST road just under 5 miles long has been constructed by the California Highway Commission. The road is concrete, 20 ft. wide, and forms a link in a heavily traveled state highway in Ventura County. It is, therefore, both the longest test road ever built and the first of consequence to be tried out in regular highway service. The Bates, the Pittsburg and the Arlington roads were all planned for accelerated traffic tests and the Syracuse road is an old structure resurfaced. All other test roads have been short stretches for special local studies and are remembered only locally. As a record for reference when in the future reports of behavior are made, the construction of the California test road is given rather detailed presentation here. This account is arranged from a statement by A. D. Griffin, resident engineer, in the monthly publication of the California Highway Commission.

The pavement design, as may be observed from the accompanying chart and construction detail sheet, Figs. 1 and 2, is changed every 1,200 ft. except for two longer sections at the beginning and end. Arrangement of the different sections is such that any effects due to possible variations in quality of the subgrade, or a heavier traffic in one direction than in the other, will balance one another, when the results for the entire five miles are combined and compared.

The center-line V-groove under which is placed a submerged wood strip and the transverse doweled expansion joints, are now standard California practice. The weakened-plane transverse joints, to afford relief for tensile stresses by encouraging and localizing contraction cracking, are a new procedure. The concrete mix was six sacks of cement to the cubic yard, except for a short section which is subsequently described.

To guard against corner cracking where longitudinal edge and center bars were specified, the same type of reinforcing was carried transversely across the slab parallel to all expansion joints, except where slab reinforcement was used, when the precaution was considered unnecessary. A break in the longitudinal steel was always provided at all transverse expansion and weakened-plane joints; no steel passed through the joints except the ¾x24-in. steel dowels. These were placed with slip-sleeves on one end to provide space for expansion. Ten dowels were used in each of the expansion joints, and four dowels in each of the weakened planes. In the latter instance the dowels were spaced 6 in. from the edges and center of the pavement. Dowels were held firm by wiring them to steel pins, ½x12 in., which were driven into the subgrade as supports; the placing of dowels was given particular attention throughout the project.

Construction Program—Earth shoulders 10 ft. wide had been planned for either side of the 20-ft. pavement, which permitted two 5-bag mixers to be operated opposite each other and entirely outside the pavement side forms. Pneumatic-tired dump trucks delivered proportioned batches of rock and sand. All traffic was kept entirely off the subgrade, the hauling being done either along the shoulders or in the side ditches.

This arrangement made possible the lining up of pavement steel and transverse joints well in advance of the placing of the concrete. It also decreased confusion around the mixers and made for better progress. Further to speed up operations, the contractor provided two tampers which worked in conjunction, except for short periods when repairs were necessary. When weakened-plane joints were being placed nine finishers were required to take care of a normal day's run. Adverse weather conditions prevented any record of exceptional progress on the job as a whole, but on many days over 400 cu.yd. of pavement were placed. This is better than 900 lin.ft.

Three methods were used for the support of longitudinal steel bars in the pavement slab: (1) ½x12-in. steel pins which were driven into the subgrade and to which the longitudinal bars were wired; (2) movable braces, an invention of the contractor, which were taken out after the concrete had been spread and which were then reset; and (3) stiff No. 8- or No. 10-gage wire supports, bent and welded with stop bars and hooks, which were driven into the subgrade and the headers and left permanently in place.

The last-mentioned method proved by far the most satisfactory. The wire supports made it possible to set the reinforcing well in advance of placing the concrete. The bars were held firmly in place not only vertically and horizontally, but also longitudinally which is particularly important where breaks in the reinforcing steel must be accurately spaced for weakened-plane transverse joints. The wire supports when left in place also insured against movement of the reinforcing steel during tamping operations. All other methods of steel support have obvious disadvantages.

When slab reinforcement was accomplished with wire mesh or ⅜-in. steel square deformed bars, the procedure was as follows: A layer of concrete was struck off with a templet at the depth at which the reinforcement was to go for the full distance between expansion joints. The wire mesh sheets or the previously made-up mats of steel bars were then placed and wired to position. The mixers were moved back and the top layer of concrete was deposited, tamped, and finished in the usual manner. Of the various methods tried other than the use of wire supports, the placing of the concrete mix in two layers appeared to give the best results from the standpoint of getting and holding the steel in its proper place. To meet objections to this procedure, dusty side roads were sprinkled; the first course of concrete on hot days was run slightly wetter, and burlap mats were provided on which workmen wiped their feet to avoid tracking dirt onto the bottom course of freshly laid concrete while placing the steel.

Considerable difficulty was experienced in the construction of transverse weakened-plane joints. The special provision of the contract showed the transverse V-groove to be the same as the longitudinal center-line V-groove. An effort to follow this requirement indicated that the resulting transverse joint would not be smooth; a clean-cut V-groove by this method seemed impossible of construction without making an objectionable depression.

A method developed by Resident Engineer E. B. Brown, of Division V, for shoulder construction, was

enlarged upon and was finally adopted for full-width pavement. Under this plan the V-groove tamper was impressed in the concrete after the heavy longitudinal float had passed. In this groove a steel plate, ¼ x 1½ in. x 19 ft. 10 in., bent to roadway crown, tapered, and drilled with holes near the top to facilitate pulling, was placed about ¼ in. below the surface of the concrete. Longitudinal floating was then carried on until the pavement over the plate was as smooth as elsewhere. After the concrete had dried out sufficiently, an edger was run along both sides of the plate, giving it the appearance of an expansion joint. After about four hours the concrete was generally hard enough for the plate to be pulled and used over again. Great care had to be taken to keep the plates scrupulously clean and well oiled, as otherwise corners would be broken off at the time when they were pulled.

Departures in Design—Between station 22+60 and station 25+100, which was part of typical section A, the construction department directed that the concrete be poured five sacks to the cubic yard instead of six. Special reinforcement also was used as shown by Fig. 3. The ¾-in. smooth round longitudinal bars used on this section were greased in an effort to cause them to act as dowels over their entire length. Subsequent comparisons of this section with other sections which contain ¾-in. square deformed longitudinal bars should determine whether or not the bonding of steel to concrete for the transference of tensile stresses is of as much importance as the doweling action in the absence of a bond between the two. This section should also prove or disprove the advisability of providing against corner breaking by placing bars at 45-deg. angles.

From station 37+50 to station 39+50 poor local drainage conditions decreased the bearing power of the subgrade. To overcome this condition an additional inch in the thickness of the concrete slab and additional steel were authorized. This consisted of deformed longitudinal bars ¾ in. square placed at the edge and center in the southwesterly half of the pavement and also standard reinforcement of ⅜-in. bars placed on both sides 2 in. from the top of the slab.

On the three northerly sections containing slab reinforcement, station 42+00 to station 54+00, station 66+00 to station 78+00, and station 90+00 to station 102+00, the steel was placed 2 in. from the top instead of 3 in. as originally designed. This change was authorized because it was thought that by being placed nearer the top the reinforcement might be more effective in taking up tensile temperature stresses and the flexural stresses of heavy concentrated traffic loads. After the highway has been in use, comparison of these sections with the three where the steel is in the center of the slab should be of interest.

Because of high alkali content in the soil

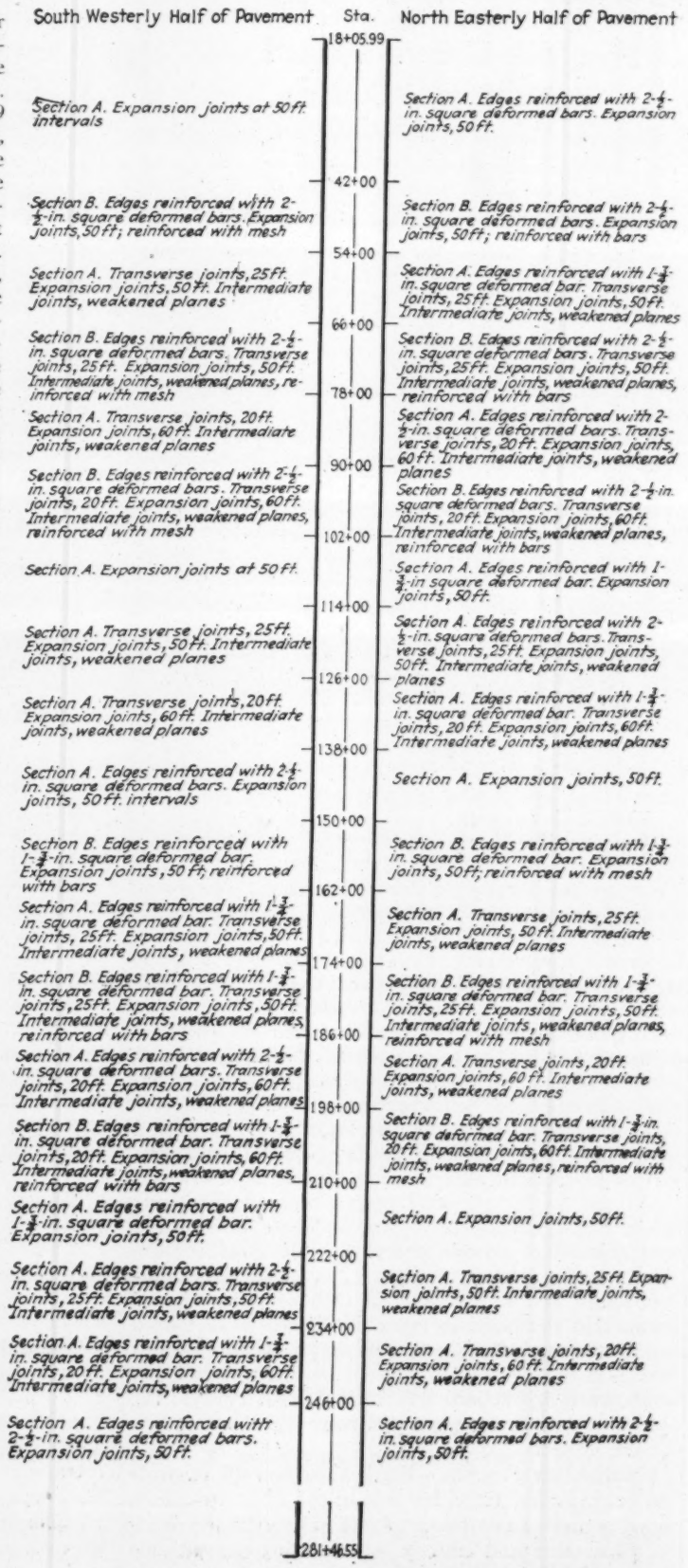


FIG. 1—CHART OF ARRANGEMENT OF REINFORCEMENT, JOINTS AND SLAB SECTIONS

from station 226+00 to station 256+00, the completed subgrade was given two applications of asphaltic road oil to secure an insulating membrane under the pavement. The first application was of oil with a 40 to 50 per cent asphaltic content, 1 qt. to the square yard of subgrade; the second application was 80 to 90 per cent asphalt, in the same amount per yard. This oil treatment was also considered a protection against the shrinking and expansion of the subgrade; and for this reason, a sand cushion between the subgrade and the pavement, which would otherwise have been placed on the northern half of this section, was eliminated. The soil was of an adobe nature having a linear shrinkage of from 5 to 8 per cent.

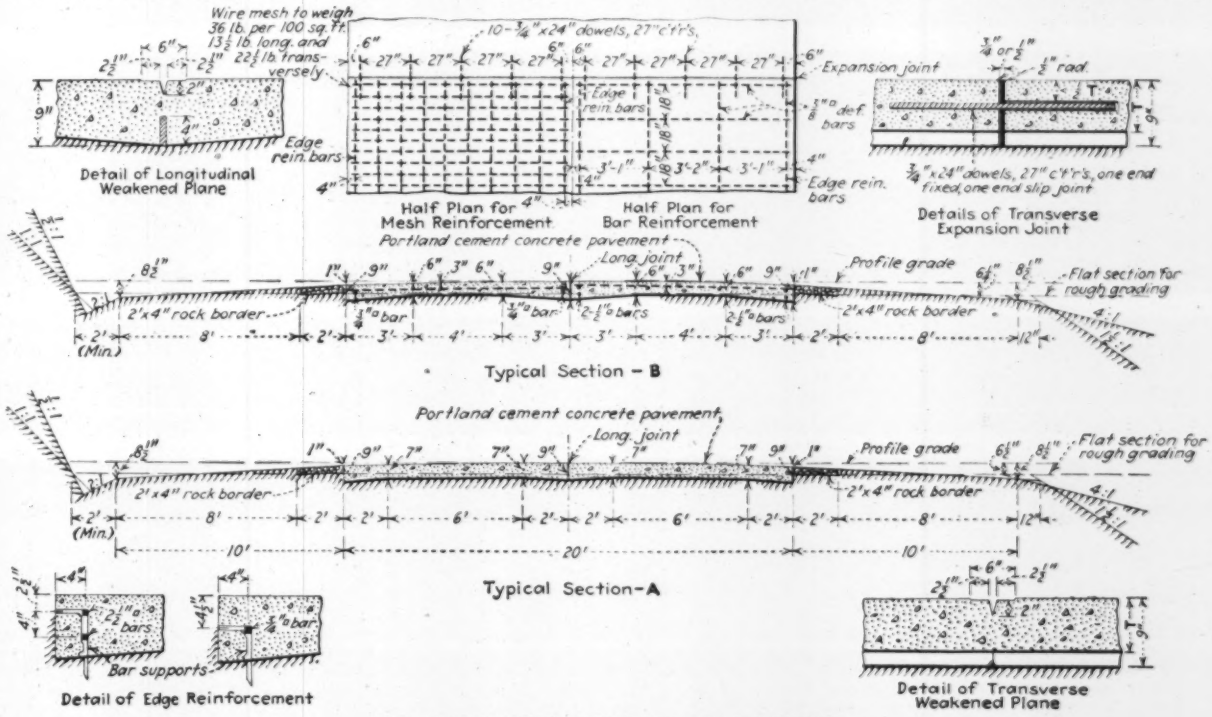

Wire mesh to weigh 36 lb. per 100 sq. ft.
Detail of Longitudinal Weakened Plane
Edge rein. bars
Half Plan for Mesh Reinforcement
Half Plan for Bar Reinforcement
Details of Transverse Expansion Joint
Portland cement concrete pavement
Long. joint
Profile grade
Flat section for rough grading
2'x4" rock border
Typical Section – B
Typical Section–A
Bar supports
Detail of Edge Reinforcement
Detail of Transverse Weakened Plane

FIG. 2—STANDARD CONCRETE ROAD DESIGNS EMPLOYED IN CALIFORNIA

The road was constructed under the supervision of the highway department engineers in the regular manner of all the roads of the state. Except to get the changes exact as charted by Fig. 1, no unusual precautions were taken in respect to materials or construction methods.

The contractor for the road was the United Concrete Pipe & Construction Co., Ventura, Calif.

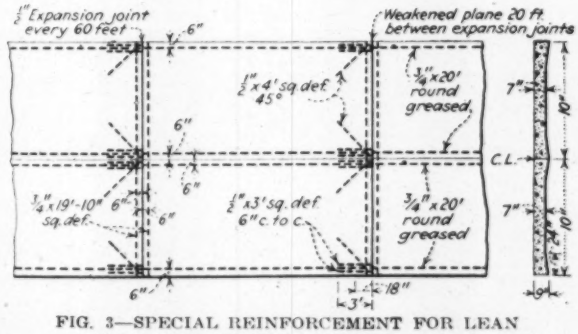


FIG. 3—SPECIAL REINFORCEMENT FOR LEAN CONCRETE SECTIONS

Delhi and Durham Now Under New Control

STATE land settlement projects in California are affected by an act passed at the last session of the legislature in that state and approved by the governor. The act specifically continues the land settlement board and makes no changes in its functions and duties but specifies that henceforth the board shall consist of but three members, who shall be the director of agriculture, the state engineer, and the director of finance, all acting ex-officio and receiving no additional compensation for this service. The act also creates in the department of agriculture an additional division to be known as the division of land settlement, which shall be in charge of a chief to be appointed by the director of agriculture and to receive a salary fixed by the director of agriculture with the approval of the governor. This change in plan of management is not expected to involve any material change in the detail of control and management of the two present state land settlement projects at Durham and Delhi, or their officers.

Railroads Spent $885,086,000 in 1926

Capital expenditures by the railroads of this country for additions and betterments and for new equipment in 1926 amounted to $885,086,000, according to the Bureau of Railway Economics. This was an increase of $136,895,000 over similar expenditures for 1925 and $10,343,000 for 1924, but a decrease of $174,063,000 as compared with 1923 figures. Of the total capital expenditures made in 1926, $513,164,000 were for roadway and structures and $371,922,000 were for new equipment. Capital expenditures for additional track amounted to $166,758,000.

Old Stone and Wood Mill Replaced by Substitution

Steel Frame and Concrete Floors Are Substituted Story by Story for Stone and Wood, with No Halt of Factory Processes

By C. F. Haglin
C. F. Haglin & Sons Co., Building Contractors, Minneapolis, Minn.

COMPLETE replacement of a five-story building with slight interruption of the regular mill processes of blanket weaving was accomplished last season by substituting new floors and walls for the old by building downward story by story from the roof. The old building had stone masonry walls and interior columns and floors of wood; the new building has a steel frame all encased in concrete, brick curtain walls and concrete floors. The two types of structure are plainly indicated by the illustrations. Neither is unusual, the feature of interest being only the procedure of substituting one for the other under the condition that all construction and shifting of machinery be done with no considerable interruption of manufacturing processes.

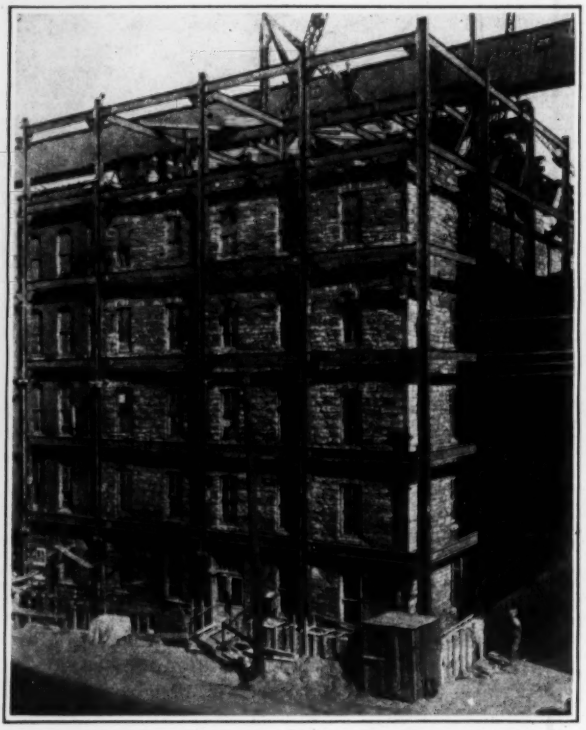


FIG. 1—NEW STEEL FRAME ENVELOPING OLD BUILDING
Interior columns erected through holes in old floors and floorbeams connected up or temporary bracing inserted not to interfere with operating machinery.

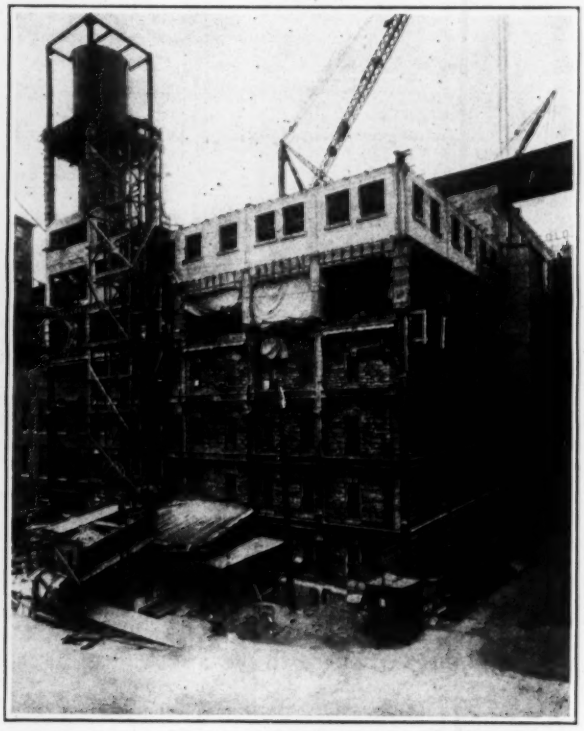


FIG. 2—NEW ROOF AND TOP STORY COMPLETED
With the completion of this sixth floor, contents of old building fifth floor were shifted up and old building fifth story was taken down.

Planning New Structure—The old mill was built in 1864 for the North Star Woolen Mill Co., which has been weaving high-grade woolen blankets for over fifty years. It occupies a very desirable site in the famous Minneapolis flour-milling district, this site having been chosen originally because of its proximity to cheap water power.

The old building was a typical structure of the time, with heavy limestone walls and timber construction for the interior columns and floors. It was built over a canal which conducts the water from the Mississippi River to an old turbine chamber located approximately 50 ft. below the curb line. The original building had been added to from time to time, the last change being an addition of two floors in height which were suspended from trusses spanning the width of the building to the outside walls; thus, the building was five stories in height, the roof, the fifth, and the fourth floors being suspended from old wooden trusses. The building was approximately 57 ft. wide and 125 ft. long.

The first problem of the contractors was then to lay out a new thoroughly fireproof building which would meet the most rigid requirements of the milling company, as to the location of machinery and line shafting, the elimination of vibration, and the elimination of air currents so as to control the humidification of the air.

It was decided to erect the new building with a structural-steel frame and reinforced-concrete floors, and brick and steel sash exterior walls. The principal reason for adopting a steel-frame building for this comparatively low structure was that it presented the only solution for erecting the new building from the roof down, so that the machinery in the old building could be transferred to the new floors without interrupting the manufacturing process of the mill. The new building was to be six stories in height and also to be wider and longer than the old building, so that it would entirely envelop the old structure.

Construction Procedure—After these problems were thoroughly studied and a satisfactory design was obtained and approved by the owners, the task developed into a problem of actual construction and of scheduling construction so as to eliminate loss of time in the production of the mill.

As the old trusses supporting the roof, the fifth, and the fourth floors of the old building were inadequate to support the necessary construction derricks required for the erection of the new steel frame, it was necessary to build new temporary wooden trusses, spanning from wall to wall of the old building, on which were placed two steel stiff-leg derricks with 85-ft. booms. These derricks were used both for erecting the new building and demolishing the old, and for transferring the heavy mill machinery from the old building to the new one.

During the time that the construction equipment was being placed over the roof of the old building, the contractors were driving caissons to solid rock, and preparing new foundations over the old turbine wheel room and canal. As soon as these footings were in place, the structural steel was erected as rapidly as it was received from the fabricators. As the area of the new building was larger than that of the old, it was an easy task to erect all of the exterior columns and spandrel beams from the footings to the roof of the new building entirely outside of the old building. It required, however, very delicate handling and accurate measurements to place the interior columns and beams as all of this material had to be hoisted over the roof of the old building and then put in a vertical position, and dropped through small holes not over 2 ft. square in the roof and all of the floors of the old building, to the footing base plates without disturbing any of the operating machinery in the old building. Thus all of the interior columns and most of the interior beams and girders were put in place before the old mill was destroyed. Wherever it was impossible to install necessary beams and girders to support the columns laterally, so there would be no interference with mill machinery, these columns were thoroughly braced with timbers and cables so that they could support the load which was to be applied from the top.

The steel frame complete is shown by Fig. 1. The old building is entirely encased with the new steel frame and the construction equipment has been transferred to the steel frame of the new building. The roof of the new building was then poured. Fig. 2, dated June 9, shows the roof and sixth floor concreted, and the sixth floor enclosed with brick walls and steel sash in place. It also shows the demolition of the old building progressing from the top downward, all materials and machinery formerly in the attic of the old building having been raised into the sixth floor of the new building. Fig. 3, dated June 23, shows the fifth floor and the fifth floor walls in place. It also shows the old building still up four floors with the machinery in these floors still in place and operating. Finally Fig. 4, dated Aug. 18, shows the old building having disappeared entirely, and the new building complete with the exception of the first floor.

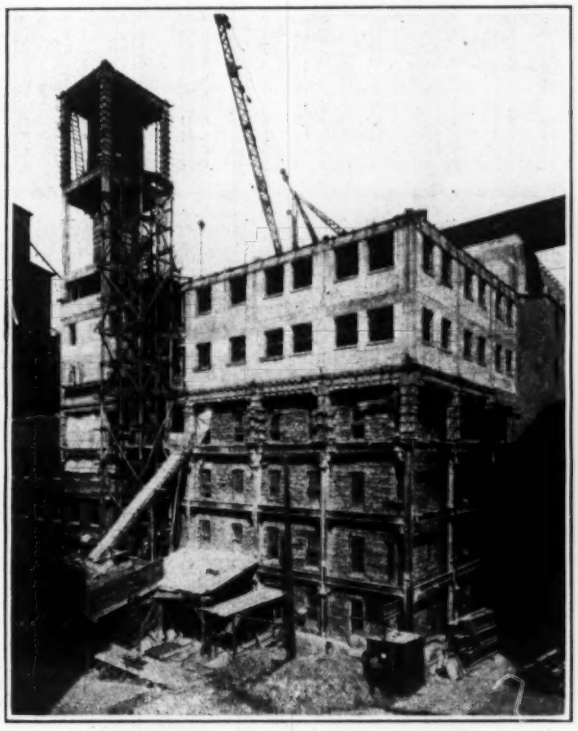


FIG. 3—NEW FIFTH STORY COMPLETED
Forms being erected for fourth story and four stories of old building still in use. This photograph was taken two weeks after that of Fig. 2.

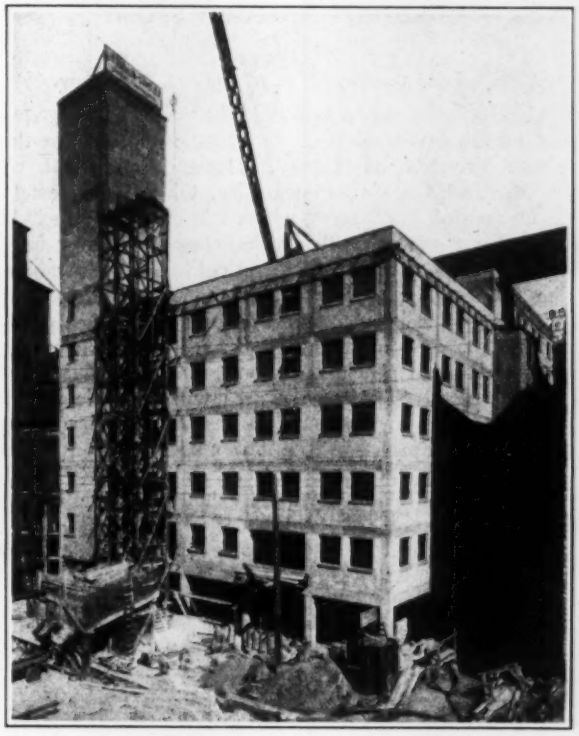


FIG. 4—NEW BUILDING COMPLETED TO FIRST FLOOR
Old building completely torn down and machines transferred to new building. First floor on independent foundations to reduce vibration.

This floor was built entirely independent of the remainder of the building due to the fact that the floor supported very heavy, vibrating machinery, and it was desired that this vibration be eliminated from the rest of the building. Therefore, all of the columns and walls of the main building were insulated with heavy cork board and the first floor was carried on independent columns to their own independent footings.

General Results—During the entire process of building the new plant, manufacturing was not interrupted with the exception of one or two days when certain heavy steelwork was being handled and it was thought wise to shut down the plant to eliminate the danger of any possible accidents to the operators of the mill; but the output in finished blankets was greater by 12,000 lb. during the

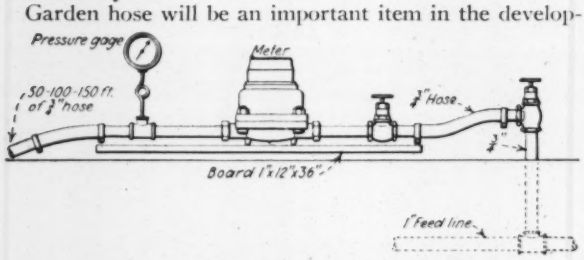
year of construction than it was the previous year. Those familiar with the machinery required in a woolen mill of this kind will realize the extreme care which the operation of moving from the old building to the new building required. Some of the machinery weighed 15 tons per unit, and on one floor alone there is concentrated $250,000 worth of equipment. During the whole construction program, none of this machinery was damaged in the least. The writer's firm was the contractor for the work.

Field Tests of the Discharge of Ordinary Garden Hose

By J. B. Marcellus
Chief, Engineering Department, E. W. Marland, Ponca City, Okla.

During the summer of 1926 the writer was engaged on the development of an irrigation system for the private grounds of E. W. Marland, president of the Marland Oil Co., Ponca City, Okla. This estate has an area of 2,000 acres, which will eventually include an immense garden, with shrubs, elaborate flower beds and vistas; a golf field and also a polo field with stables. The flood system of irrigation is not only impossible for topographical and cultural reasons but would probably not be economical, as all the water for irrigation must be pumped a height of about 100 ft. through 1½ miles of pipe. Some of the area will be made into a Bermuda grass lawn which requires but little irrigation water, while adjacent will be flower beds which must be watered almost daily. Many trees are also being transplanted. These will require individual watering for the first three years.

Garden hose will be an important item in the development of this area. A plan for a half-section (320 acres) showed the need of about fifty lines of hose. The rainfall in this vicinity is about 40 in. per year, but during the growing season the precipitation is so unequally distributed that an elaborate garden development is impossible without irrigation. Some of this estate will remain in farm cultivation to supply feed for the polo ponies. At present, five polo fields are being developed. These require special irrigation. In August, 1926, one field (9 acres) used 105,650 cu.ft. of water. A 200-stall stable for polo ponies is under way. This stable will develop a village of 200 inhabitants, with water and sewer facilities. A country club with five buildings is also under way. This means a golf course and floral surroundings, in addition to water and sewer facilities.



APPARATUS FOR TESTING DISCHARGE OF GARDEN HOSE

Consultation of indexes disclosed no data on the discharge of garden hose, so in August and September, 1926, tests were made to determine the amount of water discharged by the ordinary garden hose. The tests were made under field conditions, as time permitted. The field party rodmen often aided as observers.

The apparatus was a pressure gage, an ordinary ¾-in. meter, a ¾-in. valve, 500 ft. of ¾-in. garden hose in 50-ft. lengths, an ordinary garden hose nozzle, and a revolving spray. The garden hose nozzle was of a type adjustable to throw a spray or a solid stream, or to be shut off. In these experiments, it was always open to throw a solid stream. The nozzle opening was ¼ in. in diameter as measured by calipers. The nozzle was 4 in. long. The whirling spray had three arms slightly bent so that the reaction of the water spraying from the end of the arms through five ⅛-in. holes caused the arms to revolve. The arms were ⅜ in. in inside diameter and revolved around a standard ½ in. in inside diameter. This standard also supplied the water to the arms.

TESTS OF DISCHARGE OF GARDEN HOSE

Discharge from 50, 100 and 150 ft. of ¾-in. garden hose under 10 to 55 lb. pressure.
Gallons per minute. Pressures when water was running. Open = nothing attached to outlet end of hose. W.S. = whirling spray at end of hose. Nozzle = ordinary type of jet nozzle.

Pressure	50 Ft. of Hose			100 Ft. of Hose			150 Ft. of Hose		
Lb.	Open	W.S.	Nozzle	Open	W.S.	Nozzle	Open	W.S.	Nozzle
10	3.68	3.36	2.51	2.72	2.10	1.83	1.94	1.91	1.75
15	4.34	3.52	2.89	3.49	2.72	2.35	2.45	2.27	1.98
20	4.94	4.16	3.74	4.57	3.16	2.74	2.93	2.69	2.48
25	5.61	4.91	4.11	4.78	3.74	3.14	3.68	3.05	2.65
30	6.19	5.24	4.56	5.19	4.04	3.36	3.97	3.53	3.08
35	6.73	5.93	4.96	5.41	4.30	3.74	4.36	3.82	3.42
40	7.33	6.35	5.36	5.50	4.53	4.11	4.70	4.26	3.66
45	7.85	6.56	5.71	5.82	5.16	4.49	4.92	4.56	3.89
50	8.52	6.82	6.09	6.73	5.40	4.71	5.05	4.78	4.20
55	....	7.05	6.37	7.03	5.93	4.97	5.96	5.11	4.41

The meter, pressure gage and valve were connected together on a board which could be easily carried. This apparatus was attached by a short piece of ¾-in. hose to a ¾-in. riser from a 1-in. supply line, to which a hose is connected to water surrounding shrubbery. In some cases, a man was actually watering flowers, trees, etc., on the discharge end of the hose while the tests were being made. In all, slightly more than 300 runs were made.

The process involved: (1) The measure of pressure before the valve in the hose adjacent to meter was opened; (2) pressure reading while water was running; (3) initial and (4) final meter reading; (5) record of cubic feet passed; (6) initial time; (7) final time; (8) minutes elapsed; (9) gallons per minute; (10) length of hose; (11) hose outlet—whether open, with nozzle attached, or with whirling spray. The tests (runs) were from 5 to 30 min. long. The running pressure, or pressure when water was flowing, was from 10 to 50 lb. This pressure was regulated by the valve at the meter. The pressure in the feed line (from the Ponca water-works) varied from 40 to 80 lb., changing with the number of other users on the line. On Sunday, when some of the tests were made and no men were watering, the feed line pressure was 80 lb. The hose was laid on fairly level ground. Some tests were made to see if there was any difference in the discharge of hose laid straight and laid crooked. Very little difference could be detected so long as hose was not kinked. The accompanying table is a summary of the three hundred or more tests. The results give an indication of the quantity of water that may be discharged through a ¾-in. garden hose in actual use.

These tests were made while the writer was professor of civil engineering at the University of Colorado, and during the summer vacation of 1926. The writer is now employed as chief engineer of this development in charge of design and construction of the drives, walks, water supply, sewers and sewage treatment.

Shore-Protection Lessons of Florida Hurricane

Groins Thought to be Inadequate as First Line of Defense, But Coupled with Seawall to Elevation + 12.5 May be Considered Protective of Beach and Property

By R. M. Miller
Vice-president and Chief Engineer, J. K. Shinn & Co., Engineers and Constructors, Miami, Fla.

THE best protection now afforded the east coast of Florida, from Miami Beach to Pompano, is the flat offshore gradient and offshore bars acting as natural breakwaters. From Pompano north to Palm Beach sand dunes rising 20 to 40 ft. above mean low water form a reasonably safe barrier against loss of life, although these dunes were themselves seriously eroded during 1926. To a section expected to become, within a few years, the greatest winter playground in the world, the loss of several miles of coastal highway, the erosion of beaches, partial loss by erosion of many valuable ocean-front lots, and the total or partial wreckage of scores of fine ocean-front homes by the July and September storms in 1926, become a problem for serious consideration. Evidently the present natural protection is not sufficient.

Protection against coastal erosion and storm seas has held some of the most baffling of engineering problems. Where the littoral current is known, or where the prevailing storm direction is established, beaches that have been eroded have been built up more or less successfully by breakwaters and groins. These beaches have then become in a greater or less degree a protection in themselves. However, when a coast, like the Florida East Coast, is swept periodically by storms of hurricane characteristics with shifting seas, shifting currents, and bars, and storm tides of extraordinary height, groins must be eliminated as a first line of defense in favor of an adequate seawall barrier with or without the aid of groins or offshore breakwaters.

The coast as a whole is regular, possessing but few inlets, jetties, or other obstructions. The tidal range is something under 3 ft. The material making up the beaches is, as a rule, coarse sand that does not pack readily and is easily eroded.

Liability to Storm Damage—Weather Bureau figures indicate that the centers of tropical hurricanes will visit the section between Palm Beach and Miami approximately once in fifteen years. The records also indicate that an average of a little less than one tropical disturbance approaches this section per year close enough to cause wind velocities of 40 miles per hour. The southeast phase of this disturbance is the only storm from that quarter that need be expected. From the high-pressure area off the southern Atlantic states some five or six northeast storms per year may be expected on this coast in velocity from 30 to 40 miles per hour. All of these northeast storms and the portion of the hurricane coming from that direction have a destructive effect in eroding the beaches.

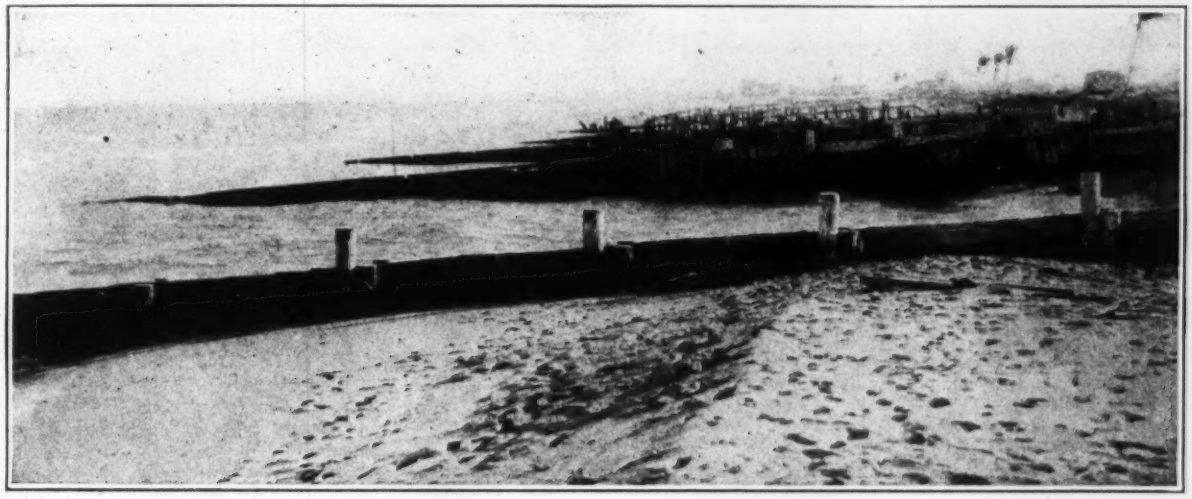


FIG. 1—GROINS HELD BEACH BUT EROSION EXTENDED HALF MILE LEEWARD OF THEM

The movement of the Gulf Stream northward a few miles from the coast of Florida causes a return current southward alongshore. This current is of considerable velocity and of some importance as a sand carrier with storms from the northeast. It is axiomatic in this section that a northeast storm erodes the beaches and good weather builds them up. This is caused, in the first instance, by the storm acting with the littoral drift moving somewhat in its own direction. The undertow transporting the sand follows the coast southward and breaks out at frequent intervals into deeper water, probably forming new bars. In the second case, the waves of translation striking the coast from south-of-east and bearing the sand from the bars probably formed by the northeast storms normally create an undertow toward the north. This undertow, meeting the littoral drift

moving in a southerly direction, loses some of its velocity and deposits the sand. As the prevailing wind is from a little south-of-east good weather may be depended upon to build up the beaches with or without artificial aid.

As there is no evidence of material recession of the coast line as a whole, it may be safely assumed that material eroded from the beaches is not lost into deep water. If the material eroded were lost into deep water, a corresponding amount would have to be transported from the north to maintain the existing equilibrium with a corresponding loss from those beaches. There is no evidence of such loss. The available sand is therefore a fairly constant quantity. While this is a valuable asset to the coast as a whole, it lends but little comfort to the owner of valuable ocean-front property whose front yard has been moved seaward by a storm and who may wait several years for its return in installments.

Exceptions are to be found to the foregoing general statement in several locations such as Palm Beach, where the loss has been continuous and very heavy with a steady recession of the coast and the partial destruction almost annually of portions of the Coastal Boulevard

up during this phase, it was not comparable to the erosion that had earlier taken place.

Attempts at Protection—Numerous attempts have been made by hotel, apartment, and private property owners between the Government Cut at Miami Beach and Palm Beach to protect their property against erosion and against the destructive effect of storm seas by the use of seawalls and groins, and combinations of the two. The groins are of many types—high, low, normal to the coast line or normal to the supposed resultant of the littoral drift and a northeast storm; some are long, others are short. The spacing seems to have been guided by no rule.

Fig. 1 shows ten groins built in a sufficiently substantial manner. The photograph was taken between two groins that had functioned well for some unknown reason during the September storm, building out the beach to the end of the groins for several hundred yards on the weather side. Leeward of these successful groins, however, erosion was so destructive as to all but undermine a valuable apartment building. The erosion continued for a half mile to the leeward, as can be seen in

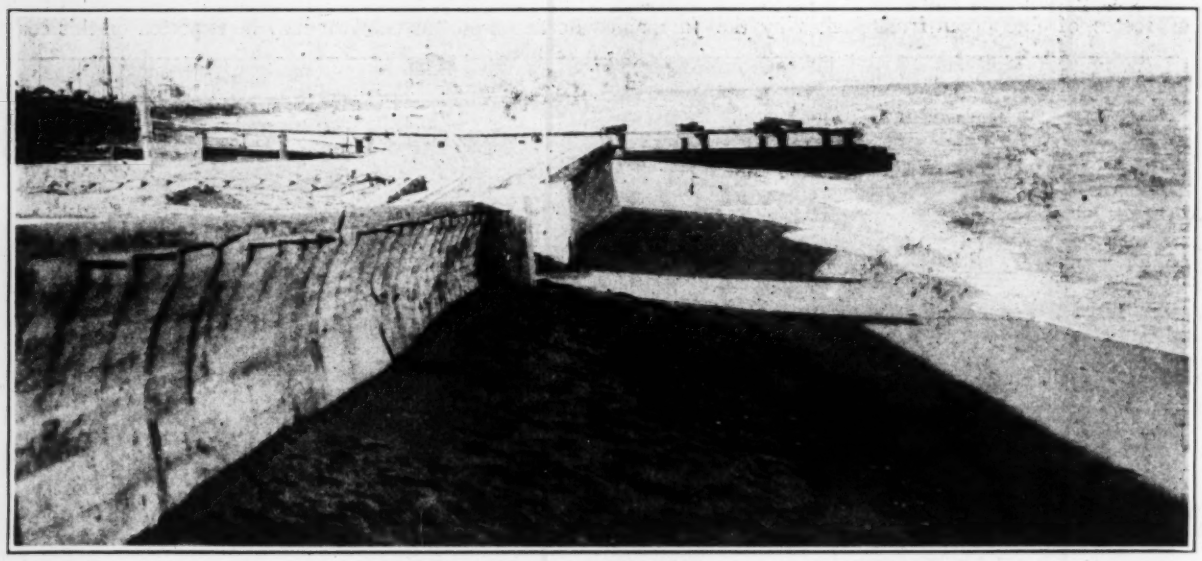


FIG. 2—EROSION STOPPED BY SEAWALL WHICH, ITSELF, WAS DAMAGED

from storms of varying intensity. This was probably due originally to the location of the reefs but of late to the construction of the jetties at the Inlet, erosion occurring as usual to the south or leeward of these obstructions.

Breakers at the plunge point along the east coast of Florida are usually not of great magnitude. Due to the gradient offshore and the offshore bars they are usually so reduced in height and velocity by the time they reach the beach as to have lost a great part of their energy. Even during the September hurricane pressures per square foot against bulkheads and seawalls were not excessive. It is doubtful if these breakers were over 7 ft. in height, but their frequency was such as to put quickly into suspension immense quantities of the coarse beach sand, which then moved with the littoral current and undertow. This was particularly the case while the storm came from the northeast quadrant. As it shifted to the southeast the intensity of the storm had materially decreased. While there must have been some building

Fig. 2, where it was brought up by a seawall, also demolished by the storm. This view was taken looking northward toward the point where the groins alluded to are located. Good weather has since the storm built the beach back where the erosion was heaviest in width from 50 to 75 ft.

Fig. 3 shows a typical system of groins entirely denuded of material, while the erosion to the leeward of these groins is shown in Fig. 4, although at the time the photograph was taken the beach had rebuilt 50 to 60 ft. A few groins collected a small amount of sand as the result of the hurricane. One system, set at what was apparently considered normal to the resultant of the littoral drift and a northeast storm, had to all appearances functioned perfectly. A further examination proved, however, that this apparently artificial berm extended to the northward and southward from this point for many miles to the same, or higher, elevation.

Protection Afforded by Groins—Under constant conditions, groins may be counted upon to build up a beach,

which in itself is some protection against storm. It is doubtful, however, if these artificially built beaches lasted more than a few hours under the sledge hammer blows of the September hurricane. With any storm tide overtopping a groin by 2 or 3 ft., as occurred during the July storm, and with seas breaking over with great frequency, scour from overfall is sufficient to denude quickly the groin of its material on the leeward side to below the original level of the beach. Following this, the groin breaks up in greater or less degree, depending upon its construction.

The difficulty of holding sand within a set of groins that stood perfectly can be appreciated when it is understood that hurricane seas that came first from the northeast shifted to east and southeast and that the current shifted from south to north in the space of a few hours. What originally was the weather side became the leeward side.

Prior to the September hurricane a considerable proportion of the groins constructed had apparently functioned with some measure of success. The results of the 1926 storms on the East Coast of Florida, however, have led to the opinion that here they are fair weather devices that merely aggravate the trouble during severe storms unless backed by a substantial seawall. It is a serious question whether the intervals of time between tropical disturbances or northeast blows are of sufficient length to allow accretion extensive enough to afford real protection.

FIG. 4—EROSION TO LEEWARD OF SYSTEM OF GROINS

Seawall Construction—Due to the slight elevation of the Miami Beach territory—5 to 6 ft. above mean low water—beach-front residents have not built seawall barriers higher than to +7 or +8. Much higher seawalls have been constructed at Palm Beach. The reason for this is to keep the ocean in sight from the front porch. However, when still water level during a hurricane is raised to +8, and even as high as +10, this pleasure becomes of minor importance. There is no evidence, however, from many recorded elevations taken of still water levels attained during the September hurricane, with and without barriers against which the sea may pile, that the still water level would attain a height greater than +10.5. As a view of the sea can be had over a seawall built to elevation +12.5, located 100 ft. in front of the average residence, such a barrier, if properly constructed, would have prevented such destruction as is shown in Fig. 4.

FIG. 3—GROINS DENUDED OF MATERIAL: CONCRETE BULKHEAD FAILED THROUGH IMPROPER DESIGN

Numerous seawalls had been constructed prior to the September storm, a few of which are shown in Figs. 2, 3 and 4. Fig. 3 shows a concrete bulkhead improperly designed. The remainder of the illustrations cover seawalls fairly well designed with the exception of foundations. In fact, nearly all of the failures, which were relatively small, were due to the foundation failure. The large majority of these light concrete barriers stood remarkably well.

One of the light walls was selected that showed no trace of cracks or other harm. Stress of 40,000 lb. per sq.in. for steel reinforcement was assumed as reasonable. Wave pressures per square foot were then computed, beyond which pressures the wall could not have stood. It was found that pressure per square foot against these walls could not have exceeded 1,200 lb.

In spite of the prevalence of the belief that masonry seawalls cause erosion to the beach directly in front of them, no evidence of this could be discovered at any point, excepting in front of vertical bulkheads where scour was heavy. In fact, the reverse was found to be in some measure the case, as occurred to the beach in front of the Esplanade seawall at San Francisco. The beaches in front of curved seawalls, with the gradient of the beach nearly tangent to the curve of the wall, appeared to be considerably benefited.

In view, then, of the Florida East Coast experience, it is felt that the stress should be laid, first, upon an adequate seawall barrier, preferably of elliptical sea face, which will hold in place valuable property; and second, on a system of short groins at the toe of the seawall "properly designed, located, and constructed."

Reproduction of such structures as the Esplanade seawall at San Francisco, the Galveston seawall, shore-protection works for the coast of British Guiana, and others of like magnitude, would give security to life and property, but such structures are out of proportion to the needs. The results obtained by existing and comparatively light structures on the coast indicate clearly that a seawall barrier, located above high tide and rising to a maximum height of +12.5 can be built at a comparatively low cost and accomplish everything expected of more heroic construction.

Studies of the Permeability of Porous Plates

Aparatus for Permeability Determinations and Discussion of Effect of Temperature Variations on Values Obtained

By Wallace L. Howe
Research Laboratories, Norton Company, Worcester, Mass.

SANITARY engineers who use porous plates as air diffusers in the activated-sludge process of sewage treatment have established rigid specifications for the permeability and uniformity of plates. The permeability of a plate is described as the number of cubic feet of air passing through 1 sq.ft. of area in 1 min., under a differential pressure of 2 in. of water. It is expressed to the nearest tenth of a cubic foot.

The larger manufacturers of porous plates have adopted this method of rating, no matter whether the plates are to be used for air diffusion, for filtration, or for other purposes. In these specifications no mention is made of temperature. It is the purpose of the present paper to discuss the effect of temperature on permeability, as well as to describe a method for determining permeability.

Apparatus and Method of Test—The apparatus developed for determining the permeability of porous plates is shown by Fig 1. Large compressors supply air to the apparatus; an incoming air line is led into a large tank which serves to equalize line pressure fluctuations. From this tank it passes into the proper one of three flow meters of the sharp-edged office type. The metered air then passes into the plate box (Fig. 2) and is uniformly distributed beneath the plate.

The method of testing for permeability consists in first clamping the plate in the plate box, and then admitting air through one of the flow meters by opening the proper gate valve. The pressure beneath the plate is allowed to build up until the pressure gage registers 2 in. of water above atmospheric pressure. At this moment the quantitative flow is read from the manometer which has been previously calibrated for the area of plate under test to read directly in cubic feet of air per square foot of plate area. Permeability values thus obtained are affected by testing conditions; namely, barometric pressure and temperature. Barometric pressure affects only the volume of air indicated by the flow meter, while temperature affects both the volume of air indicated by the flow meter and the volume of air actually passed by the plate.

The air supplied by the high pressure compressors when allowed to expand to approximately atmospheric pressure has a relative humidity of about 15 per cent. This value is quite constant and is one of the conditions of the tests.

Effect of Temperature and Barometric Pressure—The general equation for the flow of fluids through an ori-

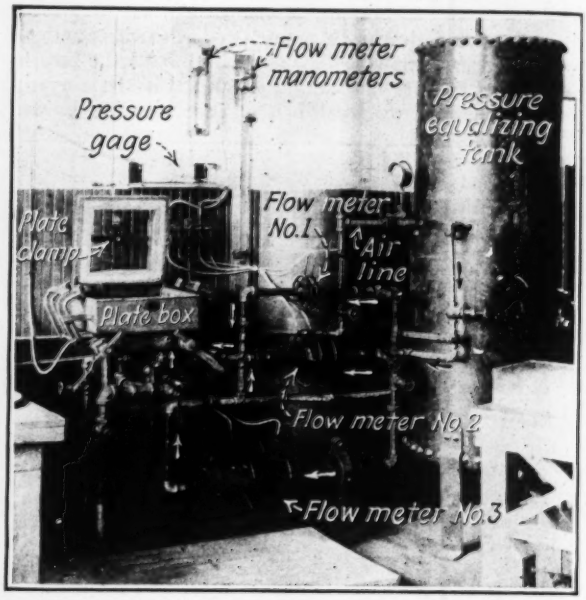


FIG. 1—APPARATUS FOR DETERMINING PERMEABILITY OF POROUS PLATES

fice-flow meter includes a consideration of temperature and barometric pressure variables (Walker, Lewis & McAdams, Principles of Chemical Engineering, McGraw-Hill; Spitzglass, *Mech. Eng.*, 45, 923, pp. 342-348; Davis & Jordan, Univ. of Ill. Bulletin 109). These can cause no great concern when properly taken into account. However, they are of importance when a commercial apparatus calibrated at room conditions of say 70 deg. F. and 29.4 in. of mercury is used under other conditions. When neglected they result in apparent changes in flow through the flow meter.

With a Norton medium porous plate in the testing apparatus, experiments were made using different air pressures against the plate, and it was found that the velocity of the air passing through the plate was directly proportional to the pressure head and therefore in agreement with Poisseuille's law governing stream-line flow of fluids through capillaries. For a given capillary this law (Walker, Lewis & McAdams, as above) is:

$$P = K \mu v$$

where P = pressure drop
μ = viscosity of the fluid
v = average velocity
K = constant

From this law it is to be expected that the permeability of a porous plate will be inversely proportional to the viscosity of the air. The viscosity of air increases with temperature but is practically independent of pres-

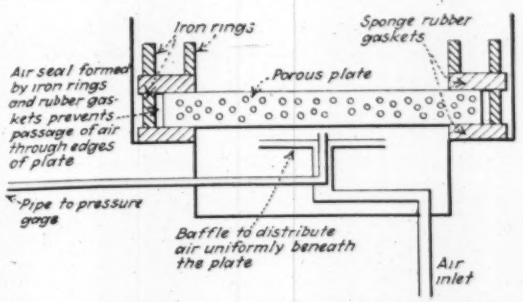

Iron rings
Sponge rubber gaskets
Air seal formed by iron rings and rubber gaskets prevents passage of air through edges of plate
Porous plate
Pipe to pressure gage
Baffle to distribute air uniformly beneath the plate
Air inlet

FIG. 2—PLATE BOX FOR PERMEABILITY TESTS

sure (Wilson & McAdams, *Engineering News-Record*, Oct. 26, 1922 p. 690). It is obvious then that less air should be passed at higher temperatures on account of higher viscosities.

Experimental results at different temperatures obtained by heating the incoming air are shown in the accompanying table. Several thermometers were placed on the air line on both sides of the flow meter and above and below the porous plate. Permeability readings were taken when indicated temperatures were all the same.

EFFECT OF TEMPERATURE ON THE PERMEABILITY OF A NORTON MEDIUM POROUS PLATE

Permeability in Cubic Feet of Air per Minute per Square Foot

Temp. Deg. F.	Apparent Permeability	True Permeability at Testing Temperature
59.2	16.81	16.63
67	16.52	16.45
70	16.40	16.40
75	16.30	16.37
85	16.01	16.22
97	15.52	15.91

Barometer 29.4 in. mercury.
Air 15 per cent relative humidity at 70 deg. F.

In the table the apparent permeability is the value read from the manometer scale calibrated at 70 deg. F. and 29.4 in. of mercury. The true permeability is this value when corrected according to the laws governing the flow of fluids through an orifice flow meter to give the actual flow of air through the plate at the testing temperature. The values when plotted (Fig. 3) show that the decrease in true permeability was proportional to the increase in temperature. If the true permeability at 70 deg. F. is calculated by means of Poisseuille's law from the average plot of true permeability at the different testing temperatures, it is found to be constant within a tenth of a cubic foot.

This particular set of data has been chosen because it covers a temperature range which has been normally

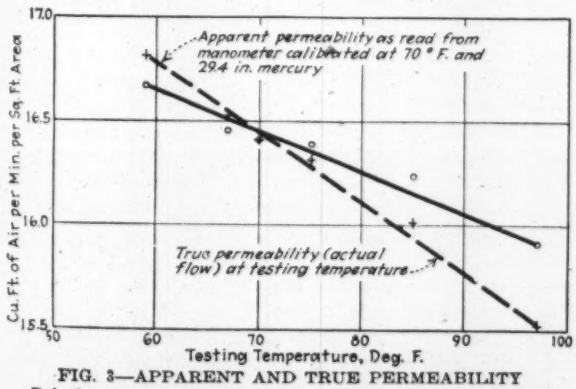


FIG. 3—APPARENT AND TRUE PERMEABILITY
Relation between testing temperature and true permeability to air at testing temperature of a Norton medium porous plate.

encountered, and so shows what permeability variations may be expected. Other experiments have been made at temperatures as high as 180 deg. F. and the same relation between the true permeability of the plate and the viscosity of the air was found to exist.

A working correction chart (Fig. 4) has been developed to cover the range of temperatures normally encountered in testing plates for permeability. It is based on an average barometric pressure of 29.4 in. of mercury, but may be used in connection with barometric pressures varying from 29.0 to 29.9 in. of mercury without involving an error of more than 1 per cent. Apparent permeabilities at testing temperatures of 60 to 100

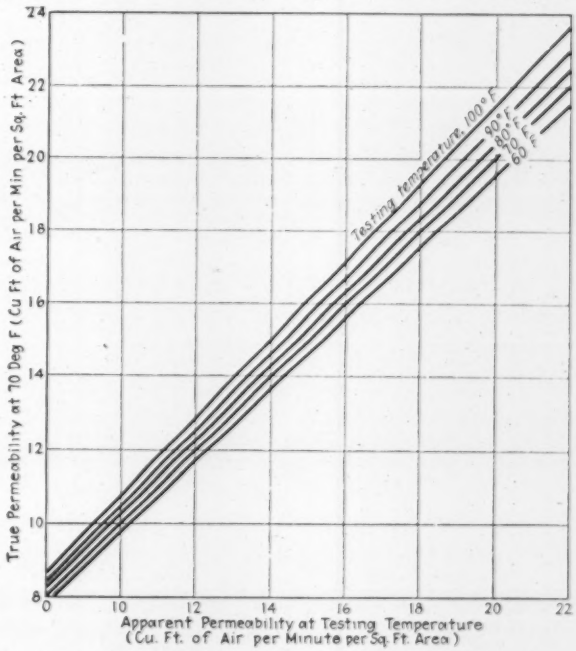


FIG. 4—CORRECTION CHART FOR CONVERTING APPARENT TO TRUE PERMEABILITY

deg. F., as read from the manometer calibrated at 70 deg. F., are plotted against the corresponding true permeability at the standard temperature of 70 deg. F. Thus far the study has been confined to plates with permeabilities of from 10 to 20 cu.ft. per minute.

Conclusion—The effect of temperature on permeability is of such a magnitude as to suggest its inclusion in permeability specifications where close limits are desired.

Change in Car-Wheel Design

A proposed change in the design of cast-iron car wheels, in which an important feature is a flange heavier than that of the present American Railway Association standard, was accepted at the recent annual meeting of the Mechanical Division of the association, and will be submitted to ballot vote of the Division. This change, prepared by the committee on Wheels, adds $\frac{1}{16}$ in. of metal on the gage side of the flange and $\frac{5}{64}$ in. on the back of the flange, making a thickening of $\frac{9}{64}$ in. and a total width of 1⅜ in. for the flange at the measuring line, which is ⅝ in. below top of rail head. This change has been approved already by the American Railway Engineering Association, so far as it affects track conditions. Also tire depth and width of rim are increased.

Timber Framing, Multi-Story Industrial Buildings

Structural, Economic and Fire-Protective Aspects Are Favorable—Comparative Costs—Examples of Warehouse and Factory Buildings—Joisted and Laminated Floors

IN CONSTRUCTION of multi-story warehouse and manufacturing buildings, which represent a considerable proportion of modern building activities, there is extensive use of the timber frame type commonly known as "mill construction" but more significantly as "slow-burning heavy timber construction." This type of building consists essentially of brick or concrete walls, timber interior columns, timber girders and beams and floors of heavy planking. Several modern examples are described in the present article.

Five-Story Carpet Warehouse—A typical structure, with unusually ornamental treatment, is the five-story

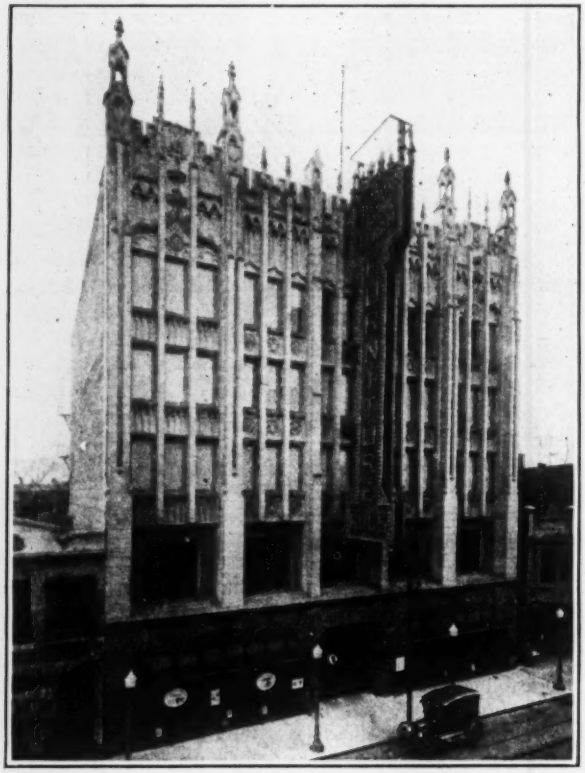


FIG. 1—TIMBER-FRAME BUILDING WITH ORNATE ARCHITECTURAL DEVELOPMENT

Carpet warehouse and showrooms. Steel framing in street front of building.

carpet warehouse and showroom of Strauss & Schram, Chicago, built in 1926 (Fig. 1). It is approximately 75x150 ft., but the rear half is inclined about 20 deg. from the front owing to a diagonal street. The column spacing is unusually wide, normal panels being about 24x16½ ft. The unusual story height of 16½ and 15 ft. in the first two stories is to provide for hanging 12-ft. rugs. All floors are designed for 100-lb. live-load.

Long-leaf yellow pine is used for structural material, and maple for floor wearing surfaces. The posts range from 16x18 in. to 10x10 in. Post caps of steel angles form seats for the posts above and for the floor girders, but wood corbels carry the 8x16-in. roof girders. From the plan, Fig. 2, it will be seen that girders, spanning the shorter length of the panels, are pairs of 10x16-in. timbers bolted together, with ¾-in. oak separators be-

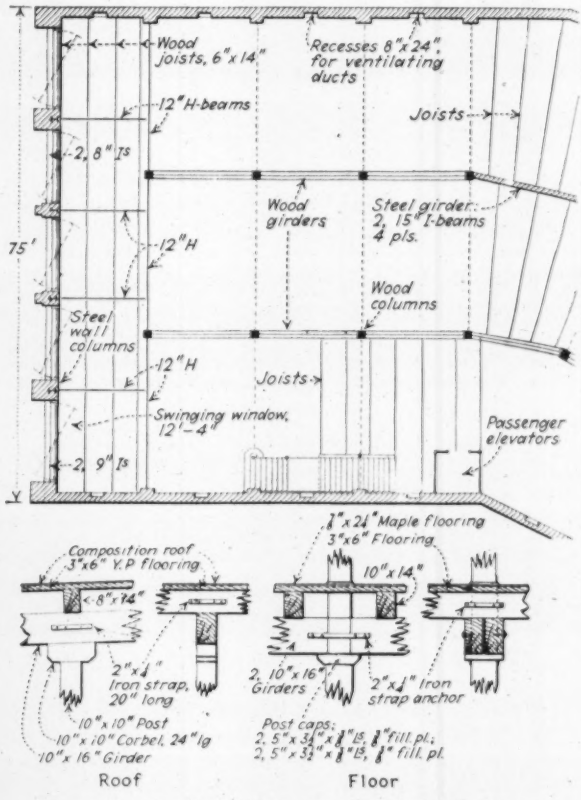


FIG. 2—FRAMING OF CARPET WAREHOUSE

tween. Across the girders are laid 10x14-in. beams, spaced 4 ft. c. to c., carrying a sub-floor of tongue-and-grooved 3x6-in. plank, on which is the wearing floor of maple, ⅞x2¼ in., toe-nailed to the planking. The side and rear walls are brick bearing walls, in which the girders and beams rest on ⅜-in. plates.

Steel framing is used in the front wall and adjacent panel because of the large window openings and the city requirement that walls must not be carried on wood beams. The front wall has steel columns and spandrel girders, and the first row of interior posts carries lines of transverse H-beams, from which 12-in. H-beams extend to the front wall columns to brace the wall framing. A steel girder is used also in one of the interior panels of each floor, where the angle of the building gives a 26-ft. spacing between two columns. The posts rest on their concrete footings by cast-iron base plates, each having a stud or dowel to enter a hole bored in the bottom of the post.

Red face-brick and white terra cotta are used in the end walls, while the side walls are of common brick. Partitions are of hollow tile. Interior brick and tile surfaces are plastered and painted buff. The front part

of several stories is devoted to showrooms, and these spaces are plastered and have wood casing around the posts to represent large octagonal columns. All the exposed wood is stained and varnished. Windows (in the end walls only) have wood sash and plain glass. Large windows, 11 to 12 ft. wide, have sash pivoted vertically at the middle. The sprinkler equipment, on the wet system, is connected to a 20,000-gal. tank on a steel tower supported by the brick walls of the freight elevator shaft.

A material saving in cost was the main reason for the use of timber construction. The total cost was about $300,000, and it was estimated that a concrete building and a steel-frame building with concrete floors would have cost respectively 15 and 25 per cent more, exclusive of finished wood floors on the concrete slabs. In addition, there was a saving of about thirty days in erection. The building was designed by A. Epstein, architect and structural engineer, Chicago.

A Large Furniture Factory—The framing of a five-story factory and warehouse building, 488x73 ft., erected in 1926 as an addition to the plant of the Berkey & Gay Furniture Co., Grand Rapids, Mich., is shown in Fig. 3. It was designed by the Detroit office of Lockwood, Greene & Co., Inc. It differs from the warehouse described above in having the beams carried between instead of upon the girders, and more widely spaced.

For the upper stories, interior columns spaced 18 ft. carry longitudinal girders 14x16 in. Between these girders and ¾ in. above their top surfaces (to allow for shrinkage) are beams 8x16 in. spaced 9 ft. Alternate beams are carried by steel stirrups at mid-span of the girders and by the column caps, which are of special four-way design with the two girder seats ¾ in. lower than the beam seats. Where the floor planks pass over the girders, leaving the ¾-in. space, two wrought-iron

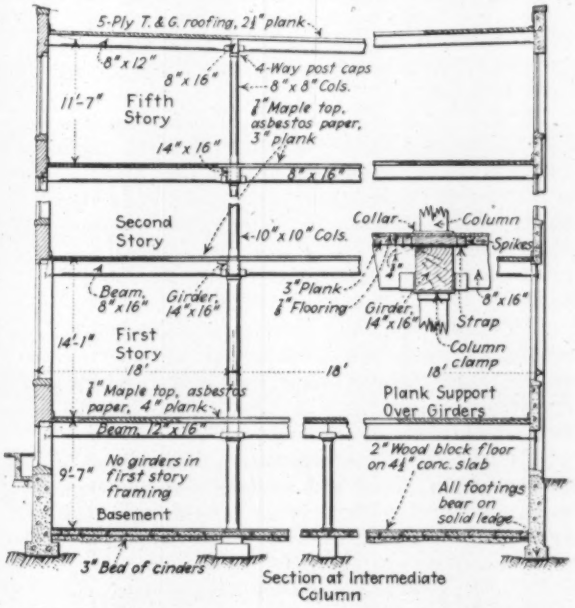


FIG 3—TIMBER FRAMING OF FURNITURE WAREHOUSE

straps 1¾x⅜ in. are spiked under the planking at each column with 5-in. wire spikes bent over and clinched. These upper floors are designed for 80-lb. live-load.

The framing construction is modified for the first floor, which is to carry a 125-lb. live-load. As girders for this load would be of such size as to reduce the basement headroom undesirably the longitudinal girders were omitted, beams 12x16 in. were used and intermediate columns were placed in the basement to support the alternate beams.

Floors consist of a bottom course of 3-in. plank (4-in. for the first floor) covered with a layer of asbestos paper, upon which is ⅞-in. maple. In the basement, a

FIG. 4—SEVEN-STORY BUILDING WITH TIMBER FRAMING
Clothing factory. The height is unusual for this type of construction.

2-in. wood block floor is laid on 4½-in. concrete. Mastic flooring is laid in all toilet rooms.

At four recessed truck-loading spaces on the first floor, each 24x17 ft., the wall ends of the beams are carried on 28-in. H-beam lintels. On the first floor also are two tracks, occupying an arcade 30 ft. wide, extending across the building. This arcade has brick walls carried up to the second floor level, where it is spanned by concrete girders in the walls and by intermediate girders of 30-in. I-beams which support the columns of the upper floors.

Seven-story Timber Building—While five or six stories are generally specified by building codes or other regulations as the limit for timber-frame buildings, a clothing factory and warehouse for Hart, Schaffner & Marx, Chicago, is seven stories high. It is about 159x100 ft. and has no basement. The heights from floor to floor are 14 ft. in the first story and 12 ft. 5 in. in the upper stories. This building, Fig. 4, was erected in 1919 and was designed by F. E. Davidson, architect, Chicago.

The column spacing gives panels mainly 16 ft. x 17 ft. 4 in. and the floors are designed for 175-lb. live-load. Posts are 16x16 in. to 10x10 in.; their steel caps support floor girders of pairs of 8x16-in. timbers, between which are 8x14-in. beams carried in stirrups. By placing the beams between the girders and thus reducing the depth of floor framing it was possible to get seven stories within the 100-ft. height to which buildings of this class are restricted by the Chicago building code.

Except for the first floor, which is of concrete, the floors consist of 3-in. yellow pine covered with waterproof building felt and a 1-in. maple wearing course. For the roof, the girders are single timbers 10x14 in.

with 8x12-in. beams and 2-in. boards covered with composition roofing. Steel sash is used. Interior partitions are of plaster on metal lath, the lath being fastened by screws to top and bottom sill timbers.

At the time this building was erected its cost with timber framing was approximately 20 per cent lower than monolithic concrete and 23 per cent lower than steel-frame with concrete floors. The insurance rating on the building and contents was less than $50 a year more than if the building had been of fireproof construction and equipped with sprinklers, and was considerably less than if it had been of fireproof construction and not so equipped. Further, the building was erected complete in three months, while it was estimated that monolithic concrete would have required seven months. Other important considerations were the ease with which alterations may be made in a timber-frame building (this structure is located in a manufacturing district and a change in tenancy might require alterations for elevators or conveyor chutes) and the large salvage value in case changes in the character of the district should make some other type of structure desirable within a period of 20 to 25 years.

Laminated Floors—In addition to the two arrangements of girder and joist floors represented in these buildings, laminated construction is sometimes used, dispensing with the joists. In this construction, planks placed on edge and packed together to form a solid floor are laid across the girders. It is said to cost about 20 per cent more than the others, but gives a flat ceiling.

The laminated floor is used more especially where heavy floor loads are to be carried or where clear ceiling space is desired in large bays. It is used sometimes on steel framing, as in a building designed by Lockwood, Greene & Co., Inc., for the Hamilton Mfg. Co., at Two Rivers, Wis. Here the panels are 10x30 ft. and the floor system is designed for 175-lb. live-load. The floor is of 2x6-in. planks placed on edge, closely packed and nailed together. At intervals of 24 in. the floor is fastened to the steel framing by lag screws through holes in the girder flanges. Upon this wood deck is the wearing surface of ⅞-in. maple flooring. The roof is of similar construction, but with 2x4-in. planks on edge covered with four-ply asphalt roofing. In the timber-frame warehouse of the Elmer Richards Co., Chicago, designed by A. Epstein, the 6-in. laminated floors are made of 3x6-in. planks with ⅞-in. maple flooring.

Municipal Government in Bombay Presidency

As one of its lines of activity, the local Self-Government Institute of the Bombay Presidency, India, is conducting training classes for municipal officials. The first class, in session from April to June, 1927, numbered some forty students. A second class will begin in August of this year and further sessions will be held later. The Institute is a federation of all the local governing bodies in the Bombay Presidency including "village panchayatas, rural boards and town and city municipalities and corporations." *Engineering News-Record* is informed by the honorary secretary of the Institute (P. O. Box 5, Poona City, Bombay Presidency, India) that the Institute would welcome printed matter of all kinds, including charts, diagrams and trade catalogs, relating to municipal administration, supplies, etc., to place in its exhibit room.

Selecting Suitable Sites for Municipal Airports

Basic Requirements as Applied by New York City's Chief Engineer in Selecting a Site From Nine Proposed Locations

SELECTING a proper site for an airport is a task which many municipal engineers will sooner or later have to face, for the Air Commerce Act passed in 1926, although it provided that the federal government should chart and light the airways and establish and maintain emergency landing fields, left to the municipal authorities the task of constructing and controlling the main airports.

There are recognized at the present time certain fundamental factors upon which the selection or rejection of a specific site for an airport can be largely based. A special committee in New York City recently presented to the chief engineer of the Board of Estimate and Apportionment, Arthur S. Tuttle, for consideration a list of sites which had been suggested as available for a municipal airport. The following information extracted from Mr. Tuttle's report to the Board is a good example of how engineers must apply these recognized fundamentals if the most efficient air commerce facilities are to be provided.

In the list nine sites are suggested as available for utilization as an airport by the city. Five of the suggested sites are located in the Bronx, two are in Queens, one is in Brooklyn and one is in New Jersey.

The essential features of an airport are its availability as a landing place for both sea and air planes, an area of from 100 to 600 acres with a minimum length of 2,500 ft., and direct adequate transit facilities to all parts of the city. One of the sites in the Bronx comprises but 16 acres which is inadequate for airport purposes and one site is located in New Jersey. These two sites are not considered.

Further consideration of the conditions to be met in determining upon the suitability of a site for airport purposes led to the conclusion that the flying conditions at the site should be a governing factor of prime importance. The judgment of many pilots was practically unanimous with respect to the unsuitability of any of the other sites suggested in the Bronx for the following reasons:

(1) The present and prospective development of the adjacent territory will prohibit the ultimate expansion of the airport to one square mile in size, which area is essential in order to provide adequate and efficient facilities for all classes of aircraft.

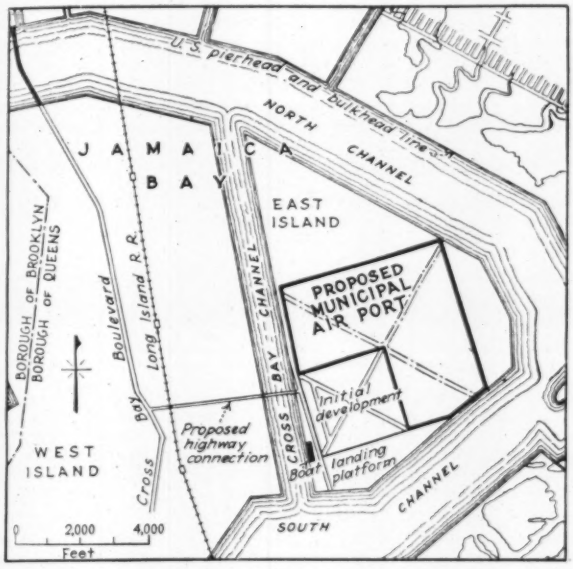
(2) The present or prospective development of adjacent territory would add materially to the hazards of taking-off and landing airplanes, and the attendant noise, particularly at night, would probably be very objectionable to residents of the vicinity.

(3) The presence of ground haze in the vicinity.

The same objections apply to the site suggested on Flushing River in the Borough of Queens, and the additional hazards of an elevated railroad line and high tension power lines in the vicinity are objectionable. Also the facilities for seaplanes are inadequate and unsatisfactory. The site in the Borough of Brooklyn is also in a territory where the advancing development is too great.

The best flying conditions to be found within the city prevail at Miller Field on Staten Island. This field is owned by the federal government and is used by the New York National Guard for the training of pilots. Even if this field could be obtained from the government, experienced pilots stated that it is more or less impracticable for the reason that the training activities of a number of pilots at the airport would seriously interfere with the operations of commercial aircraft. There is also a lack of direct transportation facilities between Miller Field and Manhattan.

A plan was proposed which contemplated an elevated



PROPOSED MUNICIPAL AIRPORT FOR NEW YORK CITY

field to be built over streets and buildings. "This plan appears to be based upon the erroneous assumption that the air rights over existing buildings in an extensive area can be pre-empted by the municipality for flight station purposes and on the further assumption that there would be no danger to the public in the operation of aircraft. I am not aware that this plan has ever had a practical test and in view of the recognized hazards, it cannot be recommended for use in New York City."

Quite satisfactory flying conditions prevail at East Island in Jamaica Bay. This territory is freer from fog and haze than other spots within the city boundaries, which is a characteristic of paramount importance to safe, regular and continued flying. The area is sparsely populated and the land contour is especially adaptable and suitable. The prevailing winds are southerly and never excessive and give the longest run on taking-off from the island.

The proposed location when developed would have an area of about 1,100 acres. An area approximately one mile square can be laid out and one-quarter, or about 160 acres, developed first and enlarged as required. A highway to connect the airport with the Long Island Railroad and Cross Bay boulevard is practicable, and a landing platform would provide facilities for transportation by water. This site is about 16 miles by rail from the Pennsylvania R.R. station in Manhattan. The airport would be constructed with sand fill from the Jamaica Bay channels, and an ample beach could be provided for seaplanes. For initial operation cinder runways 100 ft. wide would be provided.

"From such information as is available at the present time it is estimated that the development of the initial 160 acres, including the construction of the field, runways, highway connection and landing platform, would cost about $1,250,000. To this estimate there would have to be added the cost of airport equipment, including hangers, shops, markers, water supply, gasoline and oil storage facilities, drainage, etc. It should be noted that the establishment of a municipal airport, after a field has been provided, will involve the consideration of many extremely technical details, and in connection with the planning of equipment it would be necessary to obtain the advice of a qualified and recognized expert in the field of aeronautics."

Report of Committee on Subdivision of City Land Adopted

RECOMMENDATIONS of practice to be followed for the control of the subdivision of land for real estate development in and near cities, as formulated by a joint committee of the National Conference on City Planning and the National Association of Real Estate Boards, were submitted to the City Planning Conference at Washington, D. C., on May 10 by Morris Knowles, consulting engineer, Pittsburgh, representing the city planners, and were adopted by the conference. They are:

(1) That state planning enabling acts should be enacted, delegating to cities and other political subdivisions the authority to prepare general plans and to approve subdivisions.

(2) That under the authority of such an enabling act a master plan should be prepared for the area of control, showing the location of main thoroughfares, recommendations for open spaces, and designating land areas for specific uses.

(3) That the control of the platting of subdivisions should be authorized under the act, and this control exercised by the local planning commission.

(4) That the planning commission should be an appointive, non-political board, serving without compensation, and the members should hold no other municipal office excepting that certain legislative or administrative officials should be ex-officio members of the commission.

(5) That the master plan and the control exercised should extend out beyond the municipal limits into the non-municipal territory, which will sooner or later be developed as a portion of the city; this control to be developed in accordance with a regional plan in co-operation with the adjoining territorial government.

(6) That the planning commission be authorized to adopt regulations providing for the location, continuity and width of streets, to safeguard travel, prevent congestion and provide proper drainage, such regulations to include, where practicable, the minimum size and area of building lots, and the extent to which street improvements, such as water and sewer provision, should be made before the approval of the plats. In some states bonds are required from the land owner, guaranteeing the installation of these improvements. This seems to be practicable.

(7) The general requirements for principal public parks and recreational spaces and sites of public buildings should be included as a part of the master plan. Where a land owner has submitted a plat of his land and the authorities have designated in it such a principal public park, recreational space or public building site as part of the master plan, the municipality should take prompt steps to acquire such land, or, failing so to do, should act upon the plat, so that the owner can make use of his property. The subdividers should be encouraged to provide small private recreational parks.

New Data on Materials, Test Methods and Instruments

Abstracts of Some A.S.T.M. Papers—Effect of Sulphur on Structural Steel—Locating Defects in Steam Turbine Wheels by Magnetic Inspection—Applications of the Electric Strain-Gage

Magnetic Inspection of Steam Turbine Disks

By J. A. Capp

Chief of Testing Laboratory, General Electric Co., Schenectady, N. Y.

THE MODERN steam turbine may operate at speeds up to 3,600 r.p.m. and deliver power up to 90,000 kw. and more. Dependability is a requisite which can hardly be overemphasized.

All usual means of testing and inspection of the bucket wheels give no information on the homogeneity and soundness of the actual wheel. The company with which the author is connected felt that it was desirable to overcome this lack to the greatest extent possible, and means to this end were sought. Examination by means of the X-ray was considered, but the large size of the object to be examined made it impractical—a bucket wheel may be as large as 10 ft. in diameter. The steam turbine bucket wheel, however, lends itself readily to magnetic testing. It is essentially a disk, tapering in thickness from its hub to the enlargement at the rim, and is designed to rotate in a plane at right angles to the axis of the shaft. The most obvious method of testing was to rotate the wheel between the poles of an electromagnet so that differences in parts of the wheel might be indicated by measurable differences in the flux passing from pole to pole through the wheel. This method was selected as the most easily practicable one.

The test apparatus consists of a vertical spindle carrying at its upper end a chuck by which the wheel is held and

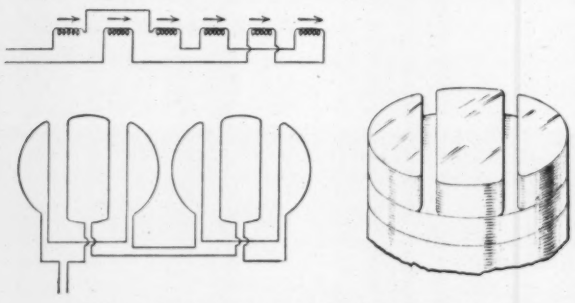


FIG. 1—POLE TIP AND MEASURING COILS

turned between the poles of the electromagnet, which consists of a yoke spanning the wheel and carrying cylindrical poles upon which the energizing coils are mounted and in the faces of which measuring coils are placed. The energizing coils are connected to a source of current and the measuring coils are connected to a galvanometer. The yoke is mounted upon rails on which it may be moved back and forth, thereby shifting the poles radially over the wheel. The poles are adjustable to the thickness of the wheel, and by means of extensions enable all parts from hub to rim to be subjected to test. The electrical connections and construction of the pole tips are indicated in Fig. 1. Experience has shown that the best results are obtained with the poles acting in series. The pole tips are grooved to provide slots for the measuring coils, which are in three sections connected astatically, so as to negative the effect of eddy currents set up in the wheel as it rotates. The measuring coils are connected to two galvanometers, one for reading deflections on a transparent scale and the other equipped with photo-recording mechanism, the sensitized paper disk of which is rotated in synchronism with the wheel under test so as to trace a circle as the wheel rotates.

By the use of a high-sensitivity galvanometer, very small things may be detected. If a rough turned wheel is tested, the galvanometer is continuously on the jump due to the wavy surface left by the roughing tool; yet these ridges are circular and move parallel to each other as they pass between the poles. A scratch on the surface of the wheel made by a scriber drawn several times back and forth will cause a large deflection of the galvanometer.

The photographic record is a convenience for filing, while

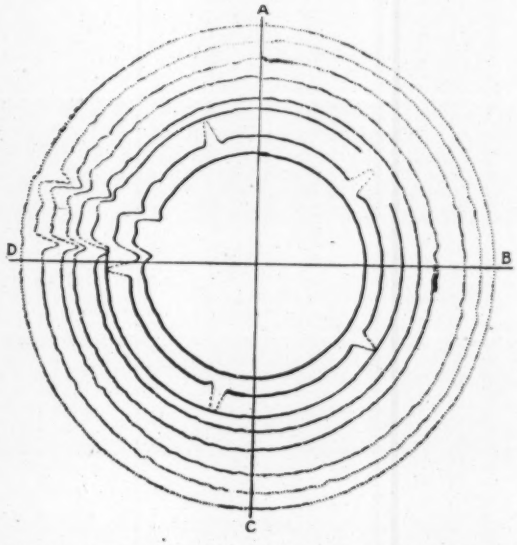


FIG. 2—PHOTOGRAPHIC TEST RECORD OF WHEEL
Shows five steam balancing holes and an area of slaggy inclusions.

acceptance or rejection of a wheel is determined by the reading galvanometer.

Bucket wheels in the modern turbine are almost exclusively forgings, but in the earlier days castings were used, and some wheels of small diameters and thinner sections were machined from rolled plate. Formerly all wheel blanks were annealed as the only heat treatment. The forgings used today are of plain carbon steel and of 3 to 3½ per cent nickel steel, and both are customarily annealed and then quenched and tempered.

A blowhole in the ingot may be flattened and slightly spread as well as drawn out during the forging. Such a seam will cause a sharp deflection as it passes the entering edge of the pole and another as it leaves the pole. In upsetting a blank to the disk form it would be possible to tear or burst the metal by too rapid reduction. Such bursts have been found. The quenching of a wheel blank may cause cracks, especially at the rim, too small to be easily seen. A bucket-wheel forging is looked upon as a high-class product warranting the use of only the best in the steel-making art, and segregated areas of inclusions are looked upon with suspicion. The magnetic test is an excellent means of locating these colonies of inclusions.

Fig. 2 shows the magnetic test record of a wheel tested after the steam balancing holes had been placed and the wheel practically finished. The five kicks in the second curve show the balancing holes. All of the curves are very smooth except in one sector where there are characteristic sharp deflections. A block machined from this sector showed the

cause of the magnetic disturbance, a band in the center of the thickness containing a really amazing amount of inclusions recognizable as of slaggy nature. The only conclusion possible was that a piece of the runner used in pouring the ingot had broken away and been carried up into the body of the ingot, where it had only diffused to a very small extent. It happened to lie in the center of the slice from which the wheel was forged, and remained in the center of thickness of the wheel web. Wheels made from adjacent slices of the same ingot passed satisfactory tests.

Notwithstanding the high standard set for bucket-wheel forgings, the manufacturers have been successful in meeting it. This is shown by the final rejection because of the results of the magnetic test of only 23 out of some 3,000 wheels tested.

It is a significant fact that we have never had a magnetic indication of trouble without finding an adequate cause. Our experience has developed confidence in the method of testing and we feel safe in the belief that this method of examining wheels supplies the needed information on the homogeneity and soundness of the wheel itself after all the other means of testing have given the usual information on its quality, treatment and structure.

* * *

Development of the Carbon-Resistance Strain-Gage

By O. S. Peters
Bureau of Standards, Washington, D. C.

SINCE the electric telemeter was developed at the Bureau of Standards four years ago, progress has been made in its further development and in its practical application. The apparatus consists of one or more small carbon resistors mounted in a metal frame arranged so as to be deformed elastically by the strain or force to be measured, in such a way as to change the pressure on the carbon and thus change its electrical resistance. This change of resistance is utilized in a wheatstone bridge circuit to indicate the effect quantitatively or to record it photographically through an oscillograph.

The chief improvement has been made in the carbon resistors, which have been changed from a 1-ohm stack of annular rings of rather soft carbon under about 5-lb. initial pressure, to a 50-ohm stack of very hard carbon of the same dimensions under about 20-lb. initial pressure, a unit pressure of nearly 180 lb. per sq. in. This increase of pressure has increased the stability to a point where a force of 1,000 g. can be applied transversely at the mid-point of one stack without altering the indications of the instrument by more than 3 per cent. Such a force produces an effect equivalent to a transverse acceleration of 330 times gravity. The error introduced by moving the gage rapidly about, as in measuring vibratory strains, is therefore small unless the frequency of the vibration and its amplitude both become much greater than is likely to be met with in engineering structures.

An apparatus was constructed by which a telemeter could be subjected to rapidly alternating longitudinal deformations. One record was taken of a mechanical displacement which took place in 0.05 sec. with a superimposed vibration having a frequency of 192 cycles per second; another, of a displacement which took place in 0.01 sec. with a superimposed vibration having a frequency of 570 cycles per second. In both cases the movement was recorded directly by levers, and also by the compression of a telemeter which it produced. The ratio of the large and small deflections checked within the possible errors of measurement in the first test, but in the other the ratio of the direct record to the telemeter record

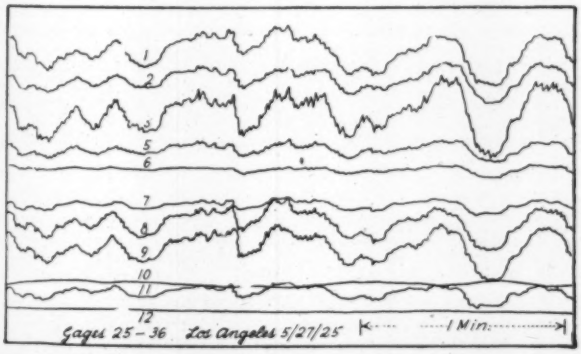


FIG. 1—STRAINS IN TWELVE MEMBERS OF DIRIGIBLE "LOS ANGELES" DURING FLIGHT

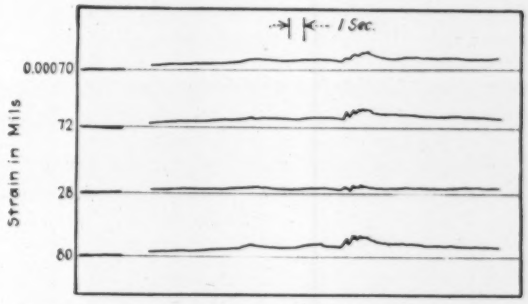


FIG. 2—TELEMETER RECORD FROM HIGHWAY BRIDGE SLAB

was 1.92 for the large deflections, and 1.48 for the 570-cycle ripple, indicating an exaggeration of the telemeter record due to the fact that the frequency of the measured vibration is too near that of the oscillograph element, which is 1200. To reproduce the 570-cycle ripple accurately would require that the natural frequency of the oscillograph be increased to about 1800 vibrations per second. This is readily accomplished, but at a sacrifice of sensitivity. Vibrations as high as 570 per second are not likely to be found in practice except under unusual conditions, however.

The record reproduced in Fig. 1 is from a rigid airship

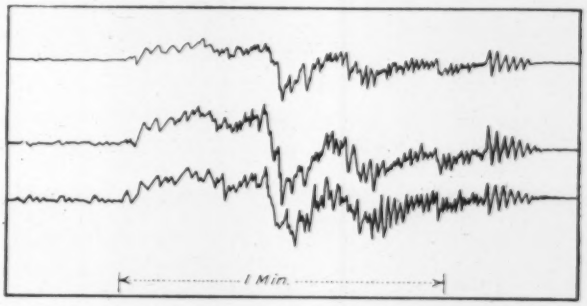


FIG. 3—STRESSES IN THREE STRANDS OF A COAL MINE HOISTING ROPE

(the "Los Angeles") in flight, with 12 carbon resistor gages attached to the keel members and girders. The large waves of stress come from pitching of the ship fore and aft in "bumpy" air. The smaller ripples come mostly from motor vibrations. The maximum change of stress indicated is about 4,000 lb. per sq.in. Fig. 2 is from a highway bridge slab of concrete supported by steel I-beams. The maximum change of stress shown for the I-beams is only about 3,000 lb. per sq.in. Fig. 3 is from the 1½-in. rope of a coal mine hoist just above the cage. The three traces are from the same length of rope, with the gages placed 120 deg. apart about the circumference. The total dead load on the rope at the time was 21,600 lb. The total travel of the cage was about 500 ft. The record indicates an increase of stress on the rope of about 30 per cent due to initial upward acceleration, and also the fact that periodically the cage traveled faster than the circumference of the winding drum.

In connection with the tests of the Stevenson Creek experimental arch dam, a measuring instrument was needed which could be embedded in the concrete at any point, and

which would give indications at the surface of the strains under changes of load, moisture and temperature. This led to the development of a cartridge telemeter. The difficulty of sealing these cartridges against water has been overcome to such an extent that it is felt that the latest type will give reliable indications for a period of years. The tube inclosing the telemeter is sealed to the frame with a flexible joint made with asphalt and rubber tubing, and the wires are inclosed in a rubber jacket with entrance sealed to prevent entrance of moisture. Under test these seals have withstood 750 lb. per sq.in. hydrostatic pressure for 2 hr. without leakage. A cartridge similarly sealed but without the rubber tube at the ends has been kept in saturated concrete for 2½ years without showing effects from moisture.

The range of each cartridge is about 0.006 in. The total change of resistance is from 22 to 75 ohms, so there is no need for highly accurate measurements of resistance to make sufficiently accurate determinations of change of length. In adjusting the cartridge prior to embedding it, allowance must be made for shrinkage of the concrete in setting, to keep within the range of the calibration of the instrument.

The general plan of a pressure gage for high fluid pressures is shown in Fig. 4. It consists of a thick tube which has two arms integral with it, long enough to permit mounting the carbon resistor between the ends of the arm transversely of the tube. When pressure is applied internally, the

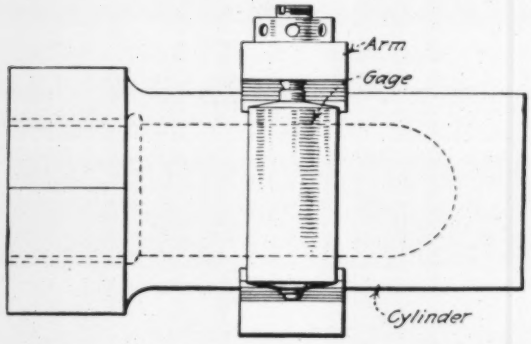


FIG. 4—PRESSURE GAGE FOR HIGH FLUID PRESSURES

tube expands. One specimen designed for 0 to 20,000 lb. per. sq.in. showed on test a change of resistance from 530 to 668 ohms, or 138 ohms total. Under average conditions of use the errors are not likely to exceed 3 per cent of the full range.

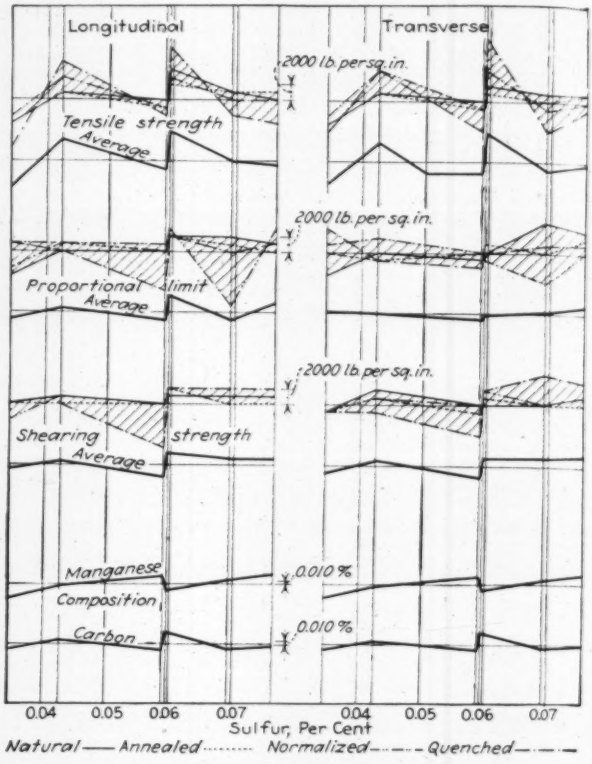
* * *

Effect of Sulphur on Plate Steel

After several years' work the Joint Committee on Effect of Phosphorus and Sulphur in Steel last year reported its findings as to sulphur in rivet steel ("Engineering News-Record," July 1, 1926, p. 26.) It found that sulphur up to 0.08 per cent has no detectable influence on mechanical properties—strength, ductility and toughness. Corresponding results for structural plate steel are now reported by the committee, again showing no injury from sulphur up to 0.08 per cent. The substance of this latest report follows.—EDITOR.

FROM test results on structural steel in the form of rolled plates, with sulphur content varying from approximately 0.03 to 0.08 per cent, the conclusion is drawn that sulphur in commercial plate material up to at least 0.77 per cent, which was the highest sulphur content examined, is not detrimental.

The following physical properties (determined for sheared and universal plate in the natural, normalized, annealed and quenched conditions) showed no systematic relation with sulphur up to 0.077 per cent: Tensile strength, proportional limit, yield point, elongation, reduction of area, shear and bend tests. Tests were made both parallel and transverse to the direction of rolling.



EFFECT OF SULPHUR ON STEEL PLATE

Results are for universal plate; curves for sheared plate are similar. Impact values are not given as the results varied erratically and indicated the unsuitability of the Charpy test for this material.

Charpy impact tests showed such wide variation of individual results that no conclusions regarding the effect of sulphur can possibly be drawn from them. It is evident that this particular type of impact test is unsuitable for rolled plate material.

In plotting the test curves a base line was first established, which represented the average value of the particular property being plotted for all heats in a given condition. The difference between that average and the actual value of that property for each heat was then plotted above or below the base line depending upon whether the difference was positive or negative. Finally, the curves thus determined were superimposed by making the base lines coincident. These curves for all physical properties show considerable irregularities, which are, however, apparently dependent mainly on the carbon and manganese content.

Registered Engineers Win Suit

As the result of a suit brought against Paul Benz, engineer for the McComb County Drain Commission, at Mt. Clemens, Mich., for practicing as an engineer although not registered as required by the Michigan law, the commission discharged him recently. It is stated that the commission originally had a registered engineer, but he went to California for a stay of several months and Mr. Benz, a former assistant, was placed in charge of the work. Registered engineers protested and brought charges, which were sustained by the county board of supervisors. The drain commission then took action as above and appointed David G. Ramsey, a registered engineer, to the position of county drain engineer.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Flow Tests of Winnipeg Aqueduct

Sir—The engineer who is accustomed to measure water by the pitot tube method will accept with some reservations the statements contained in the article entitled "Flow Tests of Winnipeg Water District Aqueduct," *Engineering News-Record*, April 28, 1927, p. 693.

The velocity of the water in this conduit is sufficiently high, ranging from 1½ to 5 ft. per sec., to enable accurate readings to be taken by the pitot tube method. A description, by the present writer, of a pitot tube suitable for this class of work was given in *Engineering News-Record*, Oct. 13, 1921, p. 616, which can be used to survey accurately the water velocities at a given cross-section.

Consistency of readings in hydraulic tests is not an indication of accuracy. The fact that a smooth curve can be established from the readings taken is no proof as to the degree of accuracy of the test.

The U. S. Department of Agriculture has been using the color method for several years in pipe-flow investigations. In this article the color method tests of 1919 show a difference of 13 per cent when a comparison is made with the salt-velocity method. One would infer from the later tests that the color method was in error.

When using the color method and the salt-velocity method, the following points are to be considered: The correct time interval which is used to determine the velocity lies somewhere between the velocity of the first traces and the velocity of the last traces. There appears to be no scientific reason why the correct velocity should be taken as the center of the curve area, as shown in the article. These two methods are not positive when accuracy is considered on account of the indefinite answers regarding the point just mentioned.

In the hydraulic tests of this character the engineer should come forth with checked data showing the degree of accuracy before making exceptionally broad and sweeping statements. In these tests one would infer that the Venturi readings were not satisfactory, the current meter readings were hard to obtain, and that the previous color method had a variation of 13 per cent.

It would be interesting to know what degree of accuracy in actual figures was in the mind of the writers of the article describing the recent tests on the Winnipeg aqueduct.

Berkeley, Calif., May 11, 1927. A. L. COLLINS, Consulting Engineer.

Sir—While Mr. Collins's observations are rather pointed and doubtless influenced by his partiality to one method, yet criticism always is welcomed. We believe almost every hydraulic engineer will disagree with Mr. Collins in that his method or any other method "can be used to survey 'accurately' the water velocities at given cross-sections." We believe Mr. Collins overlooked the statement that our method would give only a new degree of accuracy. [The authors stated that the salt-velocity method "was chosen as one that could be employed on this type of work"—gaging aqueduct flow—"and that would give a new and hitherto unattained degree of accuracy."—EDITOR.]

This salt-velocity method will not be a cure-all or the ultimate, but for work such as described we think it possesses some advantages over other methods. Having used all methods we know that each method has its advantages for particular situations.

In his fourth paragraph, Mr. Collins states that since there is a 13 per cent difference between tests made in 1919 and 1926, he infers that the color method was an error. We beg to call Mr. Collins's attention to the fact that six years' use will cause most aqueducts to become coated with algae—with a corresponding decrease in carrying capacity.

Finally we wish to call Mr. Collins's attention to the fact that a magazine cannot publish all the checked data that he requires. No engineer would publish an article without data with which to back up his statements. We will be glad to furnish any specific information desired, if inquiries are sent us at the address shown on the article.

Akron, Ohio, June 27, 1927. J. H. GRANT, Engineer, Concrete Steel Co.

Subgrade Support Under Concrete Pavements

Sir—The property of a concrete slab which enables it to distribute the weight of a concentrated load over a large subgrade area is one of the chief virtues of this excellent type of pavement.

The portion of the subgrade which is called upon to support a surface load is a circular area, the center of which is under the point of application of the load. So, when the load is applied at the edge of the slab, this valuable supporting area is reduced to a semi-circle, and when the load is moved to a 90-deg. corner, the area of supporting subgrade is diminished to a quarter-circle, a reduction of a full 75 per cent from mid-slab conditions. These are the reasons, and the only reasons, why the load-carrying capacity of a concrete slab is so much less at the edge than at mid-slab, and so much less at the corner than at the edge. The corner, then, is the weak link, and the value of the whole pavement resolves itself into a question of individual corner strength.

If it were possible to construct a subgrade, every square foot of which would be absolutely unyielding, and would always remain so under the maximum loads, the corner strength of the slab itself would not enter into strength of pavement calculation at all, for no bending stresses would ever occur. The function of a pavement, under such conditions, would be merely to shed rain, look nice, and provide a good traction surface for power-driven vehicles under various weather conditions, etc. The case is cited to emphasize the importance of the subgrade support factor in corner strength calculation as compared to the importance of the other factor, the beam strength of the slab itself.

Corner strength, then, might be expressed by the formula, Corner Strength $= 3S + b$ where S is the subgrade support and b is the beam strength. The relative weights given to S and b in the formula would be variable with local soil conditions.

Exhaustive tests have been made to determine the best methods of improving the value of b, and the result is that several ways have been found, but with leading authorities still holding widely different opinions as to which is the most efficient and economical.

Of the two ingredients which mix together to make corner strength, our tendency is to keep on increasing the expensive one to the neglect of the one that is dirt cheap, subgrade support.

We may increase our pavement thickness by two, three, or half a dozen inches, we may attach a heavy deepened edge to it, or we may buy tons of steel bars and mesh and place here and there in the concrete, all of which will add not one pound to the subgrade support. And when the subgrade support is gone, no reasonable amount of increased beam strength will hold up the corner under the continual repetition of load and the constant vibration caused by our heavy present-day motor traffic. It would seem logical, therefore, for us to look about for some means of increasing the subgrade support under our slab corners.

We will assume that, before concrete is laid, everything is now being done that is practicable to increase the soil-bearing value in pounds per square foot. The only thing left, then, is to increase the number of square feet.

Some four years ago at Longview, Wash., a pavement was built with interior slab corners of 120 deg. *Engineering News-Record*, Oct. 8, 1925, p. 580, carried an interesting account of this work, referring to it editorially as "an experiment.....yet too young in service to give records

of endurance and stability under traffic." In that case, the number of square feet of subgrade support under each corner was substantially increased, and automatically and incidentally the beam strength was also increased by 73 per cent. All this was done without the use of any expensive materials.

It was subsequently brought out in discussion before the American Society of Civil Engineers, that it was impossible to get 120-deg. corners at the outer edge of the pavement. In the case of uncurbed highways, that is very important, and as such outer edge corners must be strengthened, they can be improved only by increasing the value of *b*. But in the case of curbed city streets, the strength of these outer edge corners is not so important. A strip 6 or 8 ft. wide along each gutter is no more than a parking space, and the main stream of traffic never gets at it. If a heavy parked load does break down a corner, the subsequent wear and tear on the break, even over a long period of years, is negligible in view of the fact that the traffic count in the middle of the street is probably several thousand to one in the gutter.

In conclusion, it may be said that a gain in subgrade support under a corner is a real and permanent gain, for, once made, it cannot be lost by corrosion, crystallization, expansion or contraction, or any other such causes. Any loss of actual value will be measurable by the square foot and the number of square feet will be a factor below the line in determining the total amount of the loss.

In view of the relative amount of real and permanent gain to be obtained from an increase in subgrade support as compared to that obtained by an increase in beam strength, it is apparent that the Longview experiment should rank as a very important and really outstanding bit of research in the field of economic pavement design.

Inglewood, Calif., June 15, 1927. H. O. Root, Consulting Engineer.

Current Meter Investigations Needed

Sir—In view of recent discussion on water meters in your columns it may be in order to point out that notwithstanding the fact that current meters have been used for nearly 150 years there seems never to have been any official investigation of the relation between stream velocity and current meter action.

The meter problem, as far as it concerns meter action for practical meter work, is not a scientific problem and it is doubtful whether mathematics is applicable where most of the essential factors are either unknown or indeterminate. Perhaps a better approach to the solution of the meter problem is to consider what a current meter is expected to do and how objectives can be attained under existing conditions.

A current meter is expected to produce consistent indications which, when transposed into the rating equation, will enable the operator to determine the true, original stream velocity.

The original flow of a stream is disturbed by the introduction of an obstruction, causing a modified flow condition about this obstruction. The extent of the modification depends upon flow direction and velocity as well as upon size and form of the obstruction. A stable obstruction in a regularly flowing stream will cause a measurable modification of flow, but this is not the result if an obstruction of ever-changing form is met by irregularly flowing water and the latter condition obtains when a rotating current meter is used. The meter indications, under such conditions, are the result of modified velocity forces meeting an unstable obstruction, they are therefore neither consistent nor reliable. Flow interferences by mechanical current meters are unavoidable although they can be minimized by a proper meter design.

Stream flow in open channel is irregular in direction and of pulsating velocity. The latter is effectively integrated by rotating meters but irregular stream direction requires that the meter be actuated by the forward component of the approaching velocity forces. A meter which disregards flow direction necessarily over-rates.

The exceedingly small forces of low velocities require that the meter itself be nearly frictionless and that no eddy forces be created the influences of which upon rotation might disturb those of the directly approaching stream forces. The meter and its rotor should be so designed that the stream filaments shall be least retarded in their flow.

Inconsistent meter action is the result of eddies in various forms among which the retardation of stream flow, caused by the introduction of the meter, is perhaps the least suspected source. Its disturbing sphere extends upstream for a considerable distance, especially when velocities are low. It is readily seen that meter rotation is affected by changing flow direction.

In view of the fact that current meter calibration can be successful only when the important factors of time, length of travel, and number of meter rotations are accurately obtainable and determined while the meter is in a rigid position offering least obstruction to the water, it is essential that in actual field work similar water and operating conditions prevail in order to justify the application of the rating question.

Disregarding this requirement means erroneous meter results. Hence meter operations in fluids of viscosities much different from that of water or in turbulent streams, or gaging while the meter is restless, can not yield reliable meter indications. It is obvious that except at rating stations meter action can not be accurately repeated and reference to "accurate meter work" should be understood accordingly.

From existing literature on current meters it appears that the study of fundamental requirements for good meters has been entirely neglected, hence the diverging views regarding various meter types and their qualifications. An official investigation would do much to clarify the current meter situation.

Berkeley, Calif., June 1, 1927. Paul E. Hoff, President, Scientific Instrument Co.

Politics Eyes the Highway—Correction and Protest

Sir—In *Engineering News-Record*, June 9, p. 933, in the fifth paragraph of the editorial headed "Politics Eyes the Highway" and at about the middle of the paragraph is printed "In New Jersey a retiring commissioner, one of the leading engineers in the east, has been replaced by a local politician of persistent office-holding history and now the commission, once dominated by this engineer and a famous retired army officer, has the old general as a minority member to two gentlemen of political prominence only."

This is not only an unfair statement but it is misleading because the highway commission consists of four members. It entirely leaves out of account Commissioner Stewart who, some of us believe, has the best mind on the commission.

Atlantic City, N. J., June 13, 1927. A. H. Nelson, County Engineer.

Static and Impact Loads on Culverts

Experimental determination of static and impact loads transmitted to culverts are described in Bulletin 79 of the Iowa State College of Agriculture and Mechanic Arts. Actual tests conducted by the Iowa Engineering Experiment Station, in co-operation with the U. S. Bureau of Public Roads, showed that concentrated static loads at the surface are negligible in proportion to the load due to embankment material for depths of embankment greater than 5 ft., using culverts 42 in. in diameter and smaller. For larger diameter culverts, the static loads may be neglected for correspondingly greater depths of embankment. The actual impact load reaching the culvert varies greatly with traffic, weather, and soil conditions, but, as with static loads, the effect of impact is negligible on smaller culverts where the 5-ft. depth of embankment is exceeded.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

County Highway Officials Organize

The American Road Builders Association has just completed the organization of a national County Highway Officials Association, a body of local road officials representing each of the 3,070 counties in the United States. The new organization will function similarly to the American Association of State Highway Officials, and will be known as a division of the American Road Builders Association.

The organization meeting was held at Washington on June 17, 1927, at which time a constitution was adopted and officials elected. Thomas J. Wasser, supervising engineer of the Board of Chosen Freeholders, Jersey City, N. J., was elected first president. Four regional vice-presidents were elected. They are: Charles E. Grubb, Wilmington, county engineer of Newcastle County, Delaware; Edward W. Hines, Detroit, road commissioner of Wayne County, Michigan; John Kirkpatrick, county judge, Wayne County (Benton), Kansas; and Stanley Abel, county supervisor, Taft, California.

The constitution adopted resembles somewhat the code used by the American Association of State Highway Officials, and sets forth the purposes of the new association as those of standardization of county road building, maintenance and finance methods, dissemination and exchange of road information, and the stimulation of local road construction.

Sewage-Works for Binghamton Include Summer Activation

Grit chambers and sedimentation tanks, with an activated-sludge plant for summer use, have been recommended for treating the sewage of Binghamton, N. Y., by Fuller & McClintock, consulting engineers, New York City.

The estimated cost of these and accessory works totals $1,900,000, divided as follows: Repairs and changes in present main sewers, $100,000; new interceptors and new siphons, $550,000; pumping station and grit chambers, $200,000; sedimentation tanks and appurtenances, $550,000; activated-sludge plant, $500,000. Annual operating charges are estimated at $25,000 for pumping; $22,000 for removing settleable solids, 12 months in the year; $17,000 for activated-sludge treatment, four months in the year. The works should have an initial average capacity of 10 m.g.d., capable of taking peak loads up to 20 m.g.d. for a few hours at a time. Such a plant, it is believed, would serve a population of 100,000.

Freer International Trade Urged at Stockholm

Geneva Conclusions Enthusiastically Endorsed—Methods to Remove Trade Barriers Studied

By E. J. Mehren
Vice-President, McGraw-Hill Publishing Company, Inc.

(By Cable)

Stockholm, July 1

CONSIDERING trade barriers the chief obstacle to European economic recovery the International Chamber of Commerce has devoted its major attention to methods of their removal. Taking as a text the conclusions of the economic conference at Geneva which, in turn, were based on an exhaustive study of the Chamber's Trade Barrier Committee, it unanimously and enthusiastically endorsed the Geneva conclusions.

The delegates were told in emphatic speeches by Sir Arthur Salter, head of the economic section of the League of Nations, and by leaders of the various delegations, that they had a moral responsibility to work in their countries for the enactment of necessary legislation to make the Geneva conclusions operative; that trade barriers are strangling the nations economically; that millions are suffering; and that a reduced standard of living is general as a result. The need for quick action was emphasized, otherwise conditions may grow worse.

Other important conclusions for facilitating international trade and commercial relations relate to transport, uniform regulations regarding checks and bills of exchange and export credit. In a report, trade barriers in an international sense were defined as "those arbitrary national restraints on free movement of goods, capital and services which not only restrain trade and traders but limit the economical production and distribution of goods, capital and services to the detriment of the peoples affected by the restraint. In production there is a unit of maximum economy: in distribution there is a market of maximum economy. Any barrier which prevents the co-ordination of these two is a trade barrier in the sense used by the Chamber."

The Chamber pledged itself to cooperate with the League of Nations in carrying out the Geneva conclusions and asked its national committees to urge their governments to accept the conclusions and take appropriate action (the conclusions have already been endorsed by Belgium, Austria, Germany, Chekoslovakia, Holland and Sweden, with expressed willingness to take necessary legislative steps). It (1) endorsed the Geneva declaration that tariff walls and policies which directly or indirectly hamper trade should be reduced or removed; (2) expressed satisfaction that the League will call a diplomatic conference to draft conventions giving equality of treatment to foreigners admitted into any country and defining the conditions for exercising trade and the taxation of foreigners; (3) advocated the abolition of passport visas; and (4) urged the nations which have not done so to ratify the navigable waterways and maritime port conventions concluded at Barcelona and Geneva so that transportation barriers could be removed.

The Chamber also endorsed the abolition of prohibitions on exports and imports and a lowering of the tariff where it unduly is hampering a simplification of tariffs and the unification of customs nomenclature; long-term treaties to prevent tariff fluctuations; the abolition of exaggerated consular fees and unjustifiable health measures; the removal of prohibitions on and artificial hindrances of free international movement of capital; and finally endorsed the Geneva conclusions on rationalization and international industrial pools.

Commenting on conclusions regarding trade barriers Salter commended the cooperation of the League and Chamber. The latter, being a private body, has freedom of action, and the League looks to the Chamber for much of its driving force. He emphasized the point that the Chamber must be in advance of the

(Continued on p. 31)

Suburban Transit Board for New York Region Organized

Following its announcement that it would undertake the preparation of a comprehensive suburban transit plan for the metropolitan area at New York, (*Engineering News-Record*, June 23, 1927, p. 1037) the Port of New York Authority invited the railroads, the North Jersey Transit Commission, the Westchester County Commission, and the Board of Transportation of New York to send engineers to a meeting to be held on June 30 for the purpose of organizing a suburban transit board. These engineers met on the date set and after receiving a preliminary announcement that the Port Authority had organized a suburban transit division whose services would be made available to the board they organized as a board under the temporary chairmanship of Daniel L. Turner and went into executive session to lay out the preliminary plans for its work.

Detroit Referendum 8 to 1 for International Bridge

On June 28 a referendum election in Detroit on the question of granting a street-crossing franchise asked by the American Transit Co. to permit construction of a highway bridge over the Detroit River to Windsor, Ont., gave a vote of 66,000 to 8,000 in favor of the franchise. This action completes the last step in the series of authorizations necessary for the execution of the bridge project, which involves an 1,850-ft. suspension span. Borings at pier and anchorage sites are nearly completed, and it is expected that foundation contracts will be let in a short time by the McClintic-Marshall Co., general contractors.

The Detroit-Windsor bridge project was initiated five or six years ago by Detroit interests in co-operation with Charles Evan Fowler, now vice-president and chief engineer of the American Transit Co. The best location was found to be on a line from 21st St., Detroit, to Huron Line Road, Windsor, where the relatively short span of 1,850 ft. was practicable.

Financing difficulties which delayed the project have been overcome within the past two years by the efforts of J. B. Bower, vice-president of the New York Trust Co. The Detroit International Bridge Co. has been incorporated in Michigan to take over the assets of the American Transit Co. and the Canadian Transit Co. on the two shores respectively. The total cost of the enterprise is estimated at approximately $22,000,000.

New Syracuse Grade Crossing Plan Submitted

A review of the grade crossing elimination problem at Syracuse, N. Y., with recommendations as to the best method in which the work may be carried out, has been submitted to the city by Fay, Spofford & Thorndike of Boston. It recommends that the Lackawanna R.R. be elevated, substantially in its present location, but wholly on a private right-of-way, with a new passenger station near the present location; that the New York Central main line be removed from Washington St. to an elevated line along the present West Shore R.R. location with a new passenger station north and west of the present one; that the West Shore be elevated, and that certain isolated important grade crossings away from the center of the city be eliminated. The cost of the work is put at $26,935,000.

Wanaque Municipalities Protest Snow's Appointment

Against the written protest of seven of the eight contracting municipalities, three of the four members of the North Jersey District Water Supply Commission voted on June 30 to engage F. Herbert Snow, of Harrisburg, Pa., to review the engineering reports in the Wanaque aqueduct controversy, with the proviso noted further on. Newark was the municipality that did not join in the protest, and the absent member of the commission was the Mayor of Newark. An abstract of the engineering reports in question appeared in *Engineering News-Record*, June 30, p. 1062, while on p. 1075 appeared a note on the proposed engagement of Mr. Snow.

The objections to the appointment of Mr. Snow, according to the protest read by H. A. Lardner, mayor of Montclair, are (1) that his name was not included in the list of four engineers mutually agreed on by the municipalities and the commission and (2) that he was not agreeable to the municipalities. The latter therefore urged that since John R. Freeman is not available for engagement, a selection be made from the three remaining engineers—Allen Hazen, New York City, H. P. Eddy and Frank Winsor, both of Boston.

The commission stated that the three engineers just named are not agreeable to it because of various previous connections in northeastern New Jersey on the part of Messrs. Hazen and Eddy, while Mr. Winsor, as engineer for the Providence and Boston metropolitan water supplies, had shown a preference for lock-joint pipe. The commission insisted on being told why Mr. Snow is not acceptable to the contracting municipalities, and were told that it is because Mr. Snow is reported to have been associated with Colonel Johnson.

The commission declined to attempt to agree with the municipalities on some other engineer to serve as umpire, urging haste, and also stating that Newark and Kearney, which together will take 52 per cent of the water contracted for, stand by the commission in its proposed engagement of Mr. Snow. (Kearney was one of the seven protesting municipalities, but speakers at the conference, June 30, stated that Kearney was willing to accept an engineer chosen by the commission.) Among the grounds stated by the municipalities for insisting on an engineer-umpire, is the admission by the commission that the cost of the Wanaque project will exceed the sum named in the contract with it and that changes in the plans at variance with the contract are proposed.

The commission voted to engage Mr. Snow, provided he had not been connected with Colonel Johnson, which, it was stated, he had already said was not the case. On July 2, the municipalities received word from the commission that Mr. Snow had been engaged, he having assured the commission that he had not been connected with Colonel Johnson.

Right of States Over Power Dam Upheld by Supreme Court

The Wisconsin Law which requires owners of power dams to apply to the state railroad commission for authority to continue operation and in their application to agree to sell to the state, a county or municipality under certain conditions, was upheld by the U. S. Supreme Court in a decision rendered recently in the appeal of the Fox River Paper Co. and others against the railroad commission.

The plaintiffs in this case claim to be riparian owners of land on the Fox River in Wisconsin and own a dam at Appleton which was constructed in 1878 without the consent of any state authority. In 1925, the Wisconsin Legislature passed a law requiring operators of power dams to apply for a permit and stipulating certain conditions. The Fox River Paper Co. and its associates applied for a permit but omitted the agreement regarding sale to a public agency under the conditions stipulated under the law. The suit resulted. The state supreme court upheld the law and this decision was affirmed by the U. S. Supreme Court which points out the sovereignty of a state over navigable streams subject to the higher authority of the federal government, and asserts that should the dam subsequently be desired by the state or one of its political subdivisions, the question of a fair price could be carried to the courts in the event the operations of the Wisconsin law as to price were not considered just.

MEMBERS AND GUESTS WHO ATTENDED THE 25TH ANNUAL CONVENTION OF T

Freer International Trade Urged at Stockholm

(*Continued from p. 29*)

League with its proposals. He characterized the conclusions as a declaration not of free trade but for freer trade and said that barriers that seemed the exercise of individual wisdom had proved collective insanity and that there had now been drawn up at Geneva a decalogue of collective wisdom. Salter expressed the belief that the progress of the Geneva conclusions thus far through public declarations of the governments, through endorsement of the Chamber and through plans for diplomatic conferences, warranted the hope that, if the national committees of the Chamber will use their influence, their governments' action will result in relief for the suffering and misery of millions in Europe today. If Geneva proves fruitless there will be reason to despair that no similar substitute movement can be initiated during our lifetime.

Aside from trade barriers the meeting discussed important and generally highly technical committee reports prepared by leading experts of all nations. Among the important approved recommendations are (1) that failure to work a patent be not considered forfeiture, but that owners of non-working patents be compelled to grant licenses to third parties; (2) that each country maintain a register of the owners of patents and only registered ownership shall be valid against third parties; (3) that motor taxes be levied on highway use and the receipts therefrom be employed for highway purposes; (4) that efforts be made to improve international telephony in Europe; and (5) that a conference be called further to unify the practice regarding bills of exchange. The meeting also recommended that efforts be continued to reduce double taxation on nationals residing abroad, the principle being that impersonal taxes should be levied at the source by the country of origin and that personal taxes should be collected by the country of domicile. Other recommendations dealt with shipping documents and details of international commercial arbitration.

Alberto Pirelli, a rubber manufacturer of Milan and a member of the Dawes Committee and of the Italian debt-funding committee to the United States, was elected president of the International Chamber. Amsterdam was selected as the site for the next convention, which is to be held in 1929.

Charles W. Bryan

CHARLES W. BRYAN, chief engineer of the American Bridge Co., who died in the New Rochelle Hospital on June 25 after a serious operation performed the preceding week, was born in Warren County, Mo., May 5, 1863. He was a lineal decendent of Daniel Boone. After graduating in civil engineering from Washington University, St. Louis, in 1884, he became a draftsman with the Edge Moor Iron Co., Wilmington, Del. For three years he worked here and with C. Shaler Smith, except that for a few months during 1887 he was an engineer in the bridge department of the Missouri Pacific Ry. Advancing to the position of engineer in charge of the drawing room of the Edge Moor Iron Co., and in 1888 to the position of engineer in charge of design and estimating for the Edge Moor Bridge Works, he continued at the Wilmington plant, and in 1897 became chief engineer. He held this position until 1900, when the Edge Moor Bridge Works was sold to the American Bridge Co.

During the Edge Moor period he had developed unusual ability as a contractor in addition to his skill in purely engineering work. The American Bridge Co. appointed him as agent of the railway contracting department at Pittsburgh, and in 1901 as division contracting manager at New York. During 1906, he was appointed chief engineer of the American Bridge Co. of New York in addition to his duties as division contracting manager. Early in 1911 he was made chief engineer of the American Bridge Co.

The Edge Moor Iron Co. was founded by the late William Sellers in 1868 for the fabrication of bridges and buildings. This company and, later, the Edge Moor Bridge Works, occupied a commanding position in the early days of bridge design and construction. The original company built many bridges from the designs of the late C. Shaler Smith, one of the leading bridge engineers of his time. His well developed practice exercised a strong influence on the methods of the Edge Moor Iron Co., and its designing office soon became almost a training school for ambitious young engineers in the period from 1875 to 1890. A long list of prominent bridge engineers could be named who began their specific preparation for bridge design in the Edge Moor Iron Co.'s office. Mr. Bryan became associated with this company at a time when good practice in design and construction had been established by his predecessors, but he did much to advance that practice to higher levels.

As chief engineer of the American Bridge Co., his work was so important and varied and his contacts were so numerous that it is difficult to select particular structures as his monument. Among the great number of bridges built may be mentioned the Hell Gate, the Thames River, a large part of the Philadelphia-Camden, the Cincinnati, Florianopolis, and Carquinez Strait bridges; among buildings, such structures as the Pennsylvania Terminal buildings in New York and Chicago, the Hudson Terminal, the Woolworth and Equitable buildings.

Mr. Bryan was joint author, with the late Professor J. B. Johnson and Prof. F. E. Turneaure, of the treatise "Modern Framed Structures," first published in 1893.

Mr. Bryan was a member of the American Society of Civil Engineers, the American Iron and Steel Institute, the American Society for Testing Materials, and the St. Louis Engineer's Club, and other societies and clubs.

Agreement Near on Passenger Terminal for Cincinnati

An agreement between the Pennsylvania R.R. and the Baltimore & Ohio looking toward the construction of a new passenger terminal at Cincinnati, Ohio, has virtually been reached, according to a letter from Elisha Lee, vice-president of the Pennsylvania, to the mayor of Cincinnati. The letter from Mr. Lee to Mayor Seasongood reads, in part, as follows:

> I desire to say that it gives me pleasure to inform you that we have today (Wed. June 22) received from the Baltimore & Ohio Railroad a draft of contract embodying its approval of the proposed new connection, so that with the exception of one or two minor points upon which a conclusion probably will be reached within a short time, the terms of the contract have now been agreed upon.
>
> The length of time consumed in negotiating this contract, which has had the effect of delaying the proceedings preliminary to the proposed Cincinnati passenger terminal, is to be regretted; but I can assure you that the negotiations proceeded with as much speed as was consistent with the importance of the contract, involving, as it does, not only the expenditure of large sums of money, but binding the parties to perpetual obligations.

AMERICAN SOCIETY FOR TESTING MATERIALS, FRENCH LICK, IND., JUNE 20-24

New Orleans Council Approves Downtown Bridge Project

A franchise application of George A. Hero and Allen S. Hackett for construction of a highway toll bridge across the Mississippi River between downtown New Orleans and Gretna was approved by the city council of New Orleans on June 28. The city of Gretna had previously approved. The franchise application now goes before the Louisiana Highway Commission, which is vested with authority to grant toll bridge franchises. The promoters of the project hope to be able to begin construction late this year.

St. Lawrence Joint Engineer Board Confers

The Joint Board of Engineers on the St. Lawrence waterway project has met in Montreal to discuss details of its report which were not settled at the time the general report was presented last year. This work includes the final decisions in connection with the numerous appendices dealing with specific problems outlined in the general report. The members of the board are: Americans: Major-Gen. Edgar Jadwin, Chief of Engineers, Col. William Kelly and Lieut.-Col. George B. Pillsbury. Canadians: Duncan W. McLachlan, Oliver Lefebvre and Gen. Charles Hamilton Mitchell.

"Lake McClure" Named to Honor Late State Engineer

In honor of the late Wilbur F. McClure, state engineer of California for fourteen years prior to his death last year, the lake formed by Exchequer dam on the Merced River in California has been named Lake McClure. Many of the important irrigation developments in the state were initiated during the administration of Mr. McClure who was a recognized factor in their success. Of these projects the Merced Irrigation District served by the Exchequer dam is the largest. The action of the board of directors of that district in naming the lake after Mr. McClure came in acknowledgment of his aid and encouragement in the development of the project. Following this action by the district, the Sacramento section of the American Society of Civil Engineers prepared a bronze tablet to be put on Exchequer dam and on June 26 dedicatory ceremonies were held at the lake.

The program included a dedicatory address by Albert Given, representing the Sacramento section, to which there was response for the Merced Irrigation District by its president, D. K. Barnell. Brief addresses were also made by Paul Bailey, Mr. McClure's principal assistant, who has since last year filled the office of state engineer, and by Walter L. Huber and Harry Hawgood, representing, respectively, the San Francisco and Los Angeles sections of the American Society of Civil Engineers.

Personal Notes

SYLVIA FRAPPIER, architect, Montreal, has been appointed architect and director of the Department of Public Works and Labor of the Province of Quebec.

J. E. HAYES, of the J. E. Hayes Engineering Corporation, engineers and contractors, importers of engineering supplies, Tientsin, China, has arrived in San Francisco to remain here permanently, after an absence of eleven years. His last connection in the United States was with H. J. Brunnier, consulting structural engineer, San Francisco, Calif. In 1916 he went to the Philippine Islands as superintendent for the Construction & Engineering Co., of San Francisco, in charge of a group of buildings for the Naval Radio Station at Cavite. When these were finished, he joined the Bureau of Public Works at Manila as designing engineer but soon joined the American Trading Co. at Shanghai as assistant engineer. In 1918 he opened an office for that company in Peking and was manager of that office and resident engineer of that company until 1919. In this year he established an engineering and contracting business of his own at Peking and later in the same year transferred it to Tientsin, in 1921 establishing a branch office at Shanghai. The Tientsin office will be continued, under direction of J. K. Davison. Mr. Hayes' temporary address will be in care of Ashley & Evers, 507 Market St., San Francisco.

J. L. GUEST, of the engineering staff of the Aluminum Co. of Canada, Arvida, Quebec, has resigned. Mr. Guest entered the service of the Quebec Development Co., at Isle Maligne, Quebec, in 1923, as draftsman, and remained with this company till he joined the Aluminum Co. of Canada in 1925. He is a graduate of Cornell University, and prior to going to Canada, he was on the engineering staff of the Southern Power Co., Charlotte, N. C.

A. B. GLADLEY, formerly city engineer of Marshfield, Ore., has been appointed city manager of Burbank, Cal.

DONALD C. MCMILLAN, who was an officer in the engineers' corps during the World War and formerly a field engineer with the Southern California Gas Co., has been appointed city engineer of Ventura, Cal., to succeed Charles W. Pierce, resigned. The latter has taken a position as supervising engineer for the Austin Western Road Machinery Co. with headquarters in Los Angeles.

F. K. WORLEY has resigned from the F. K. Worley Construction Co. as of April 1, 1927, that company having gone out of business, and is now continuing in the building business as the president of the F. K. Worley Corporation, with offices at 1701 Arch St., Philadelphia.

COL. EARL I. BROWN, Corps of Engineers, district engineer of the Wilmington, Del., District, in the Northeast Division, is to be transferred on Aug. 15 to Fort Sam Houston, Texas, for duty at the commanding general's headquarters. Colonel Brown has been engineer in the Wilmington district for four years and had charge of the reconstruction of the Chesapeake & Delaware canal.

The ENGLISH CONSTRUCTION CO., of New York City, has opened an office at 3011 H St., N. W., Washington, D. C.

WILLIAM L. DARLING, consulting engineer, St. Paul, Minn., received the honorary degree of doctor of engineering from Worcester Polytechnic Institute this year on the fiftieth anniversary of his graduation from the Institute. Mr. Darling during his connection with several railways was engineer of terminals, engineer of location and of construction for various projects. He was chief engineer of the Rock Island System from 1904 to 1905, and chief engineer of the Northern Pacific Ry. from 1906 to 1916.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Summer Meeting, Denver, Colo., July 13-16, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

Obituary

EDWARD H. BLOSSOM, Macon, Ga., who retired three years ago after spending his life in the building and operation of railroads in New England, died June 20 at Macon, aged 75 years. The railroads he built were the Hardwick & Woodbury and an electric line, both in Vermont. He was general manager of the former, and had been a division superintendent of the Boston & Maine R.R.

R. A. NICHOLS, formerly county engineer of Williamson County, Texas, and a resident engineer in charge of federal reclamation work at Beaumont, Texas, died June 8 at his home in Georgetown, Texas, after a long illness.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Motor Trucks in the Construction Field

In engineering-construction service it is estimated by the market survey department of *Engineering News-Record* that there is a total of at least 250,000 motor trucks or more than 10 per cent of all the trucks registered in the United States.

This estimate is based on figures given by the National Automobile Chamber of Commerce in a recently published table breaking down a large portion of the motor truck registration into a number of classifications. The accompanying table gives such of these classifications as include trucks in engineering-construction service. The total however does not contain trucks listed under the classifications of "Quarries & Mines," "General Trucking," "Oils & Gasoline," and "Lumber & Logging," where it is estimated at least 7,500 trucks are devoted to engineering construction uses.

NUMBER AND CLASSIFICATION OF MOTOR TRUCKS IN ENGINEERING-CONSTRUCTION FIELD

Classification	Included in Survey	Adjusted Total	Total in Engineering-Construction Field
Contractors, general	74,141	137,225	137,225
Contractors, road	4,657	8,625	8,625
City, county, state	30,955	57,300	57,300
Gas, electric, water utilities	20,520	38,000 (1/3)	12,700
Building materials and supplies	18,544	34,350 (1/4)	8,590
Telephone and telegraph	10,721	19,850 (1/4)	4,960
Federal—Army and others	18,826	34,950 (1/10)	3,500
	178,364	330,300	232,900

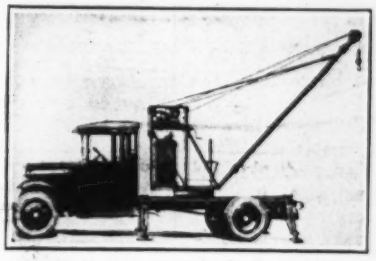
The Automobile Chamber of Commerce Survey figures for all motor truck classifications covered 1,321,230 trucks, or 54 per cent of a total registration (for year 1926) of 2,441,709 trucks. The figures in the second column, therefore, are those of the first column divided by 54 to put results on a 100-per cent basis. The fractions in parentheses are estimates of the proportions for each classification in strictly engineering-construction service.

New Developments

Truck Crane for 2-ton Trucks Is Easily Demountable

A truck crane for mounting on 2 to 2½-ton trucks has recently been brought out by the Squier-Rix Co., Milwaukee, Wis., as an addition to its line of tractor cranes. This truck crane is designed to fit without the necessity of drilling holes or in any way altering the mechanical construction of the truck.

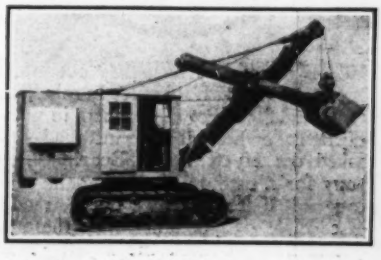
Hoisting power is a 4-cylinder 15-hp. governor controlled engine with high tension magneto connected by a belt drive to an 8x8 in. drum having 100 ft.



cable capacity. Hoisting speed is 32.5 ft. per min. The hoisting mechanism is equipped with automatic load brake, and is operated by a double clutch drive with a single lever control. The swing of the boom is also power controlled by one lever, power being supplied by the hoist motor. The boom hoist is a hand operated worm geared safety winch. The standard boom is 15 ft. long and has a full circle swing. A special feature of the crane, which makes possible the use of comparatively light trucks, is the use of four adjustable jack outriggers which are fastened to the hoist frame and not only insure stability on swinging loads, but also relieve the truck frame. A sheet metal cab is built over transmission and motor frame. The crane can also be easily detached from the truck and used as a yard derrick.

Rating of New Shovel Based On Dipper Stick Length

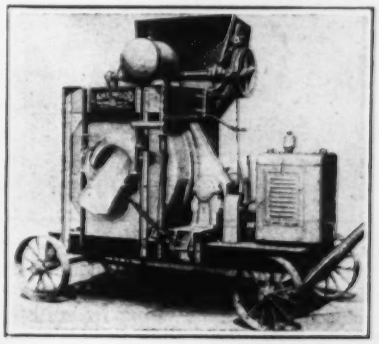
A new shovel convertible to crane or dragline as specified, has recently been developed by the Koehring Co., Milwaukee, in capacities ranging from 1 to 1½ cu.yd. An innovation in connection with this machine is the method of rating the shovel. The choice of three sizes of dippers may be had, depending upon the length of the dipper sticks and the kind of work for which the machine is to be used. With 13 ft. sticks a 1½ cu.yd. dipper is furnished; with 16 ft. sticks 1¼ and with 19 ft. sticks, a 1 cu.yd. dipper. The boom length in each case is 24 ft.



In addition to this feature, the machine incorporates a power dipper trip, a special swiveling boom-point fairlead for the dragline, cast steel car body, ball bearing mounted high speed shafts and roller bearing mounted vertical traction and swing shafts. A Koehring-Wisconsin four cylinder 6x7 in. gasoline engine, running at 925 r.p.m. furnishes the power, with an optional choice of electric motor.

Worm Speed Reduction Mixer In a New Size

Another mixer, size 10-S A.G.C. rating, has been brought out by the Lakewood Engineering Co., Cleveland, Ohio, using a worm speed reduction. This type of driving mechanism was first introduced something over a year ago on the company's 7-S and 14-S mixers. The driving unit consists of a



heat-treated steel worm mounted on ball bearings and direct connected to either a gasoline engine or an electric motor. The worm drives a solid bronze worm gear keyed to the pinion shaft, also carried on ball bearings. The entire mechanism is enclosed in a dustproof housing and runs in oil at all times. Another feature designed to give smoother operation of the mixer is the use of super-case-hardened steel for the drum roller shaft which is mounted in self-aligning cast bearings.

Electric Drill for Contractors Shops and Repair Yards

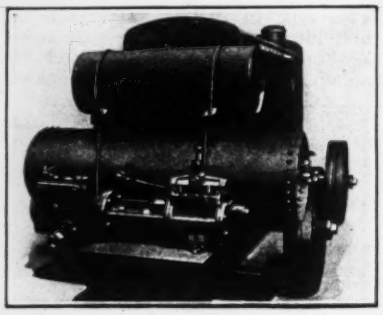
Designed to meet the needs of general shop and tool room service, and having a wide range of speeds, the "Little General" electric drill of Joseph T. Ryerson & Son, Inc., Chicago, is well adapted to contractors' use in machine shops and repair yards. A V-disk transmission drive is used in place of belts and gears. These disks are of fibre and mesh with

grooves, effecting a positive grip. The spindle swings in a complete circle around the column, enabling the operator to reach large and heavy pieces in any position.

A direct reading speed shift dial indicates each of the 18 speeds and the size of drill best adapted to the various materials. Other advantages are the long reach from the drill to the column, the small number of levers and working parts, the accurate depth gage graduated in both inches and millimeters, and the quick and convenient provisions for shifting and adjusting. The drilling capacity with straight shank drills is ½ in. By using turned down shanks it is possible to drill 1 in. in brass, or with care, in iron.

New Equipment Combines Air Compressor and Water Pump

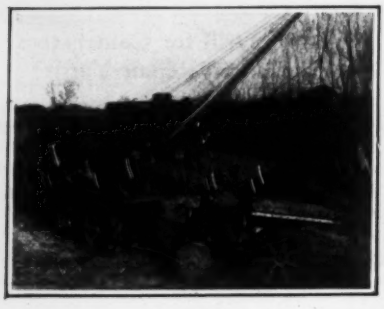
A new piece of equipment consisting of a portable air compressor on the rear of which is mounted an air driven pump was recently introduced by the Ingersoll-Rand Company, 11 Broadway, New York. It is particularly suitable for dewatering jobs and



can be used in a variety of ways. The pump will handle very muddy water and can be regulated to any desired capacity within its rating by adjusting the amount of air admitted. It is possible to obtain the pump alone, together with all parts necessary for attaching it to any Ingersoll-Rand portable compressor now in the field.

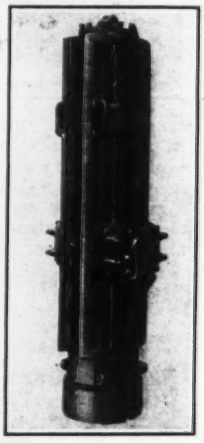
Dump Tractor Handles Easily

In order to provide a haulage unit that would not be unwieldy, would operate in tight places and would not stick in soft ground, the Hughes-Keenan Co., Mansfield, Ohio, has developed a two yard dump tractor as shown in the accompanying illustration. An ordinary Fordson tractor provides the power and chassis. The drive of the Fordson was reversed to eliminate mechanical difficulties and to provide the driver with unobstructed vision at all times. The body has a 90 degree dumping angle which permits the quick handling of even sticky materials. Besides this advantage, easy manoeuvring of the machine to the right position for dumping is one of its important features.



New Size Pile Hammer

There has been made available for distribution by the Vulcan Iron Works, Chicago, a new size double-acting steam pile hammer. This hammer, known as size E, like others of its type, has a mechanically actuated valve and uses steam or air in a compound manner, the steam exhausted from the up stroke being again used with further expansion to provide force for the down stroke. The hammer weighs 3,700 lb., 950 lb., or 25 per cent of which is in the ram. It is claimed that this heavy ram enables the machine to deliver a low velocity blow of 3,800 ft. lb., delivering about 150 blows per minute. The hammer is provided with a bottom retainer casting to accommodate both round and sheet piles.



Marking for Roller Bearing Equipped Machines

The fact that a piece of equipment is equipped with roller bearings is not always apparent to the eye, because of the hidden places in which they operate. It is stated that with this fact in mind several manufacturers of products in which Hyatt roller bearings are installed, have asked the Hyatt Roller Bearing Company for a method of making the presence of these bearings more readily discernible. Compliance with these requests has produced the Hyatt "Mark of Bearing Protection," the symbol shown in the accompanying illustration. It is stated that a number of manufacturers are now using this mark on their equipment and as time elapses others are expected to adopt it.

Electric Dredge Operated From Shore Line Cable

A hydraulic suction dredge of somewhat unusual construction is being used by the Woods Brothers Construction Company, Lincoln, Nebraska, on its seawall contract at Gulfport, Miss., the dredged material being used to fill in back of the walls.

The equipment consists of a 15 in. centrifugal dredge pump manufactured by the American Manganese Steel Co., driven by a 600 hp. 2,200 volt slip ring motor. A substation located on the shore, transforming power from 13,200 to 2,300 volts is mounted on trailers so that it may be transported by a tractor. From the substation the power is brought to the dredge through 2,800 ft. of three conductor, submersible, dredge cable suspended from tank type pontoons.

A switchboard on the dredge controls the 2,300 volt line, a 75 kva. oil engine driven generator and a transformer bank. The transformer bank reduces the incoming voltage to 440 volts for the use of the hoist motors, and pump-motors as well as for the floodlighting work. The dredge was built by Jahncke Service, Inc., New Orleans, and General Electric equipment is used throughout.

Elevating Loader with Double Hopper Increases Batching Speed

On paving contracts where two batch trucks are used, considerable saving in time has been effected by the use of double batch loaders, according to the George Haiss Mfg. Co., Inc., New York City. These loaders which the company has developed are standard loaders with the exception that the creeper mounting is 15 in. longer and the front chassis construction heavier in order to carry the double load. The hopper has a dividing plate and two outlet gates to discharge the two batches independently. It is to be noted that the double loader does not take the place of two loaders, but merely makes two batches of stone or two batches of sand

available at one time for the double batch truck, so that the truck does not have to wait with one batch on while the second batch is being placed in the hopper.

The hoppers are adjustable for a maximum of 25 cu.ft. per batch to 18 cu.ft. per batch of aggregate. By a substitution in the upper truncated pyramid section, and the bolting in place in the lower box section of some reducing plates, the capacity is changed for sand to two batches of 11 to 16 cu.ft.

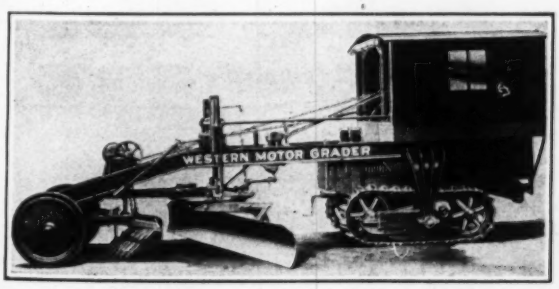
An Inundator for the Small Wheelbarrow Job

An inundator known as the Junior has been developed by the Blaw-Knox Co., Pittsburgh, Pa., for use on the small

job. This equipment, in the same manner as the larger unit, measures the sand and water, automatically eliminating the variable moisture in the sand and at the same time compensating for the bulking of moist sand. Using the inundator requires no change in other equipment.

Grader Attachment for Two-Ton Caterpillar Tractor

A motor grader attachment for the two-ton Caterpillar tractor has recently been developed by the Austin-Western Road Machinery Co., Chicago. The machine is illustrated in the accompanying



photograph and the important features of it include: Ease of attachment, solidity of completed unit, all-riveted construction, easy handling made possible by a steering mechanism of the motor truck type, the housing of all worm gears in oil type cases, a Detroit Timken front axle similar to motor truck design and roller bearing disk wheels.

New Hose Clamp

A new hose clamp has recently been announced by the National Clamp Co., 16 East 41st St., New York City. Among the features which are claimed for it

are included simplicity, the speed with which it may be applied or removed, and the fact that one size will fit a wide range of hose sizes. The clamp consists of a band upon which is embossed a toothed rack. The screw engaging with this toothed band is mounted on a trunnion. In operation the screw moving as a worm drive feeds the band under the screw threads until it is as tight as desired.

Track Machine Proves Efficiency On Railway Fill Work

A survey recently made by the A. C. Nielsen Co. for the Nordberg Mfg. Co., Milwaukee, covering the use of the latter company's track machine on railway fill work contains some interesting cost figures. The work consisted of about a million cubic yards covering between 45 and 50 acres, requiring four dumping tracks with a combined length of about 2,500 feet. The tracks were laid with 100-lb. rails, standard gage, and with ties spaced 22-in. on centers. The work of the track machine consisted mainly in shifting the track as the fill was placed from dump cars. Early in the work when all track shifting was done by hand labor, 25 men were necessary in favorable weather and 35 men in unfavorable weather. The respective labor charges are given as $94.50 and $120 per day. When using the machine the labor gang consisted of an operator, a helper, a foreman, six shovel men in favorable weather and ten shovel men in bad weather. A daily fixed charge of $4.07 was set up, based on 240 operating days per year for a seven year life of the machine. An allowance of $250 per year was made for repairs. Gasoline averaged 12 gallons and lubricating oil ½ gallon per day or a total cost of $2.92. With an operator at $5 a day and a helper at $3.50, the total operating cost was $15.49. Adding to this operating cost the labor charge of $28 on favorable days, the total cost was $43.49. This same work by hand cost $94.50; a saving of $51.01 per day was thereby effected. On unfavorable days by a similar calculation a saving of $72.01 was made.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Road Information — BARRETT COMPANY, New York, has issued a useful 48-page booklet entitled "Tarvia Road Book" containing tables and information for highway engineers, contractors and road builders. The booklet contains specifications for the various grades of Tarvia but mainly is made up of tables designed to aid in applying Tarvia and in determining costs and procedure.

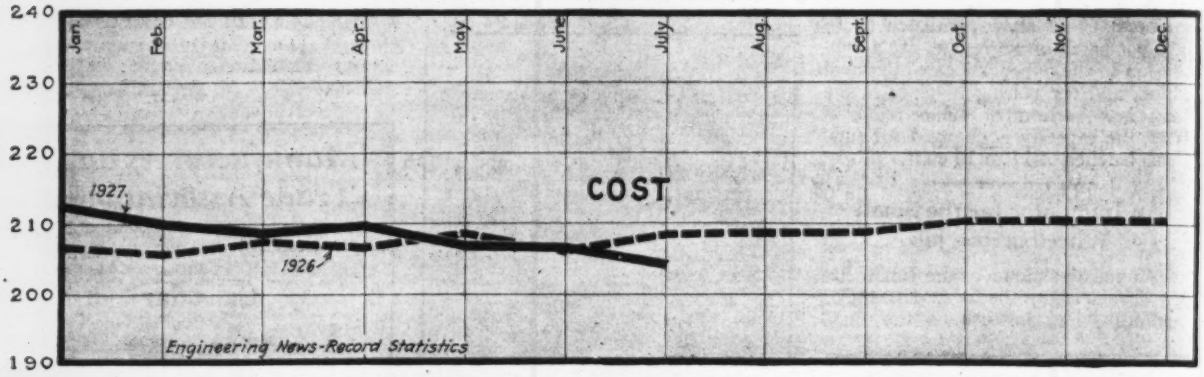
Steel Grating — HENDRICK MANUFACTURING CO., Carbondale, Pa., has made available an 8-page pamphlet describing its Mitco interlocked steel floor grating. Besides describing the construction details and giving illustrations of installations and manufacturing procedure, tables of safe loads and deflections are included.

Traffic Signals — INTERFLASH SIGNAL CORP., New York City, has available a pamphlet illustrating and describing its flashing acetylene light signals of two types—one using four lenses for regular intersections and the other using eight lenses for irregular intersections.

Pavers—CHAIN-BELT CO., Milwaukee, Wis., devotes its latest catalog No. 148 mainly to a description of its 27-E paver stressing the speed and accuracy of this machine. Illustrations are given of the machine details, such as the control lever, the power plant, cooling tank, chains, the bearings, countershafts, the rollers, etc. Specification tables are included as well as operating and dimensional diagrams.

Engineering News-Record Statistics of the Construction Industry

July 7, 1927 *in the United States* Vol.99, No.1



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY
January, 1926 to Date

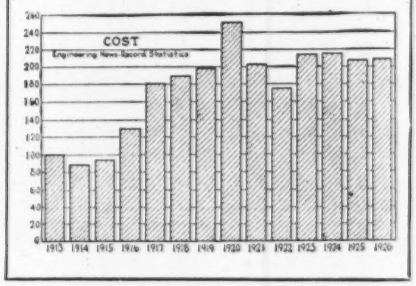
July, 1927	**203.68**
June, 1927	205.55
July, 1926	207.80
Peak, June, 1920	273.80
1913	100.00

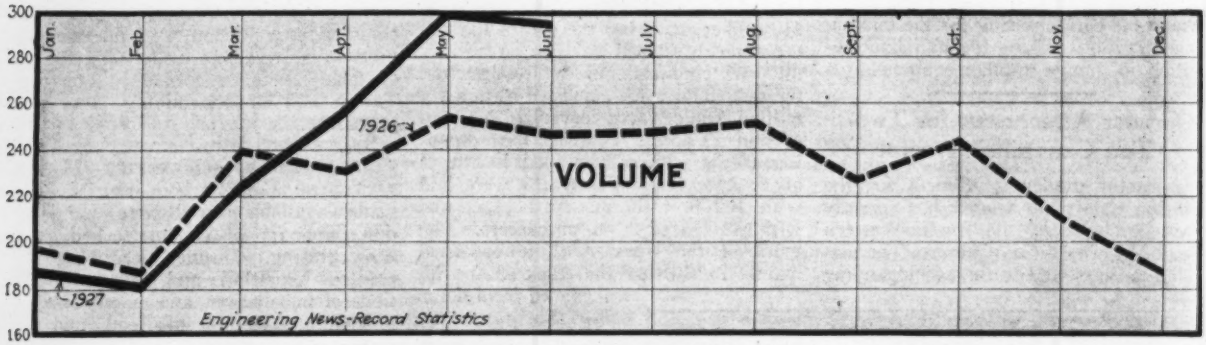
1926					
Jan.	207.15	May	207.30	Sept.	208.30
Feb.	206.55	June	204.80	Oct.	209.80
Mar.	207.65	July	207.80	Nov.	210.80
April	207.05	Aug.	208.30	Dec.	210.80

1927					
Jan.	211.50	Feb.	210.15	Mar.	208.80
April	209.00			May	206.80

Engineering News-Record's Construction Cost Index Number is 0.9 per cent below June, 1927. The decrease is due mainly to lower prices of structural steel. The average rate for common laborers is now 55½c. per hr., against 55½c. at this time last year. Skilled labor rates are at least 5 per cent above the 1926 levels. Thus, general construction cost is 1.9 per cent below July, 1926, 26 per cent under the peak and 103 per cent above 1913.

YEARLY
1913 to 1926





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY
January, 1926, to June, 1927

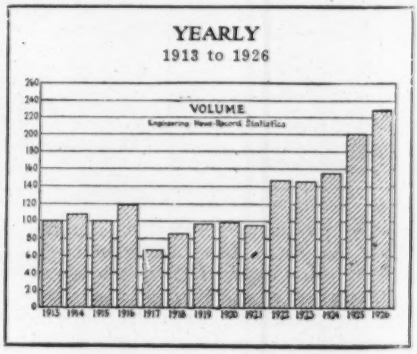
June, 1927	**297**
May, 1927	299
June, 1926	246
August, 1925	266
1913	100

1926					
Jan.	198	May	254	Sept.	227
Feb.	187	June	246	Oct.	244
Mar.	240	July	248	Nov.	211
April	233	Aug.	252	Dec.	188

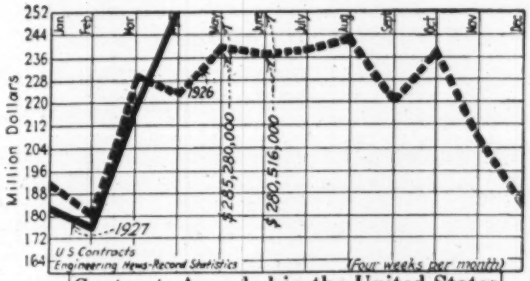
1927					
Jan.	187	Feb.	182	Mar.	226
		April	257		

Engineering News-Record's Construction Volume Index Number is 297 for the month of June and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 297 for June, 1927, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

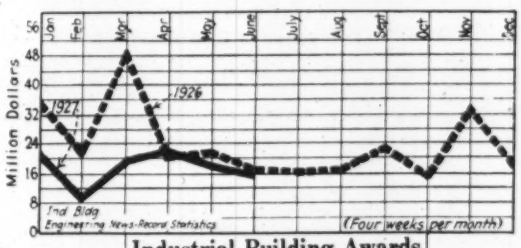
YEARLY
1913 to 1926



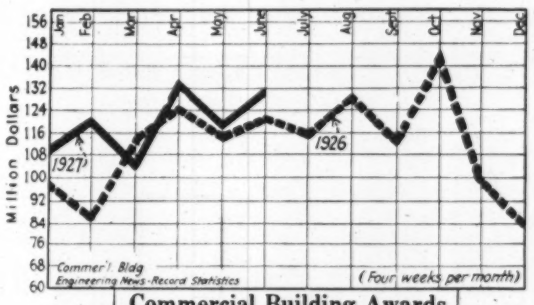
Monthly Statistics of the Construction Industry



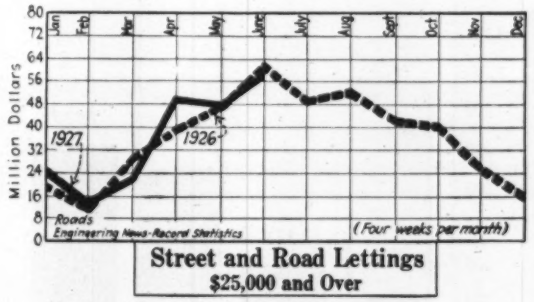
Contracts Awarded in the United States
Reported by E. N.-R.



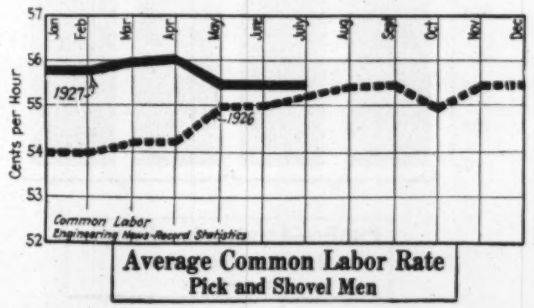
Industrial Building Awards
$40,000 and Over



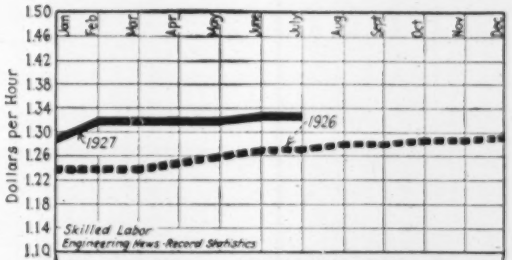
Commercial Building Awards
$150,000 and Over



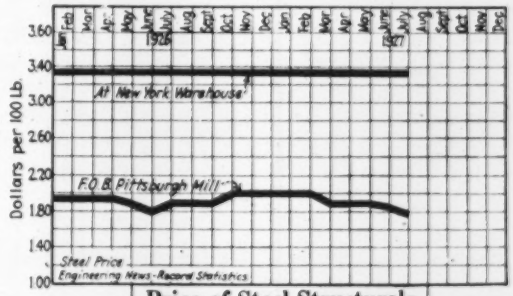
Street and Road Lettings
$25,000 and Over



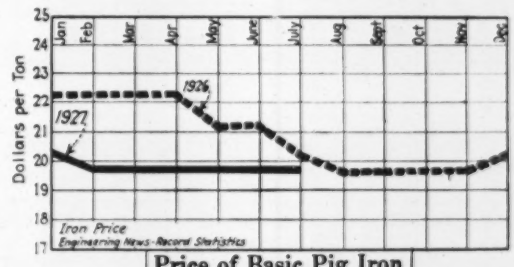
Average Common Labor Rate
Pick and Shovel Men



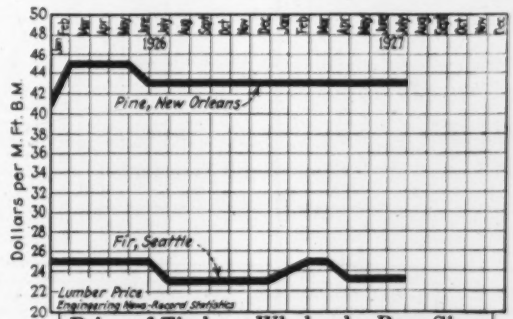
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



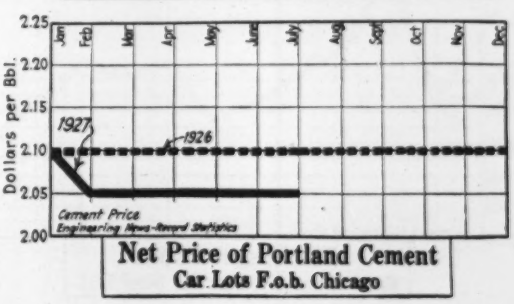
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh

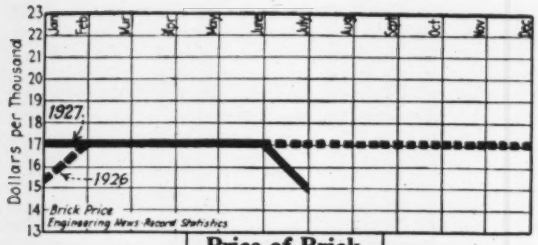


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

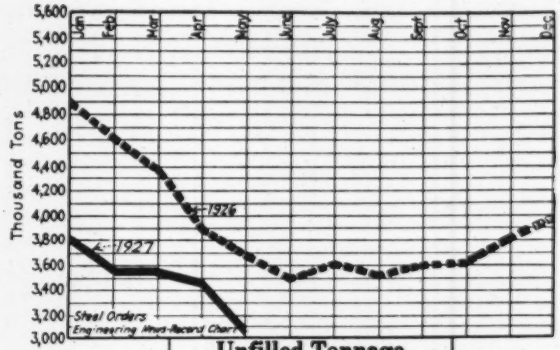


Net Price of Portland Cement
Car Lots F.o.b. Chicago

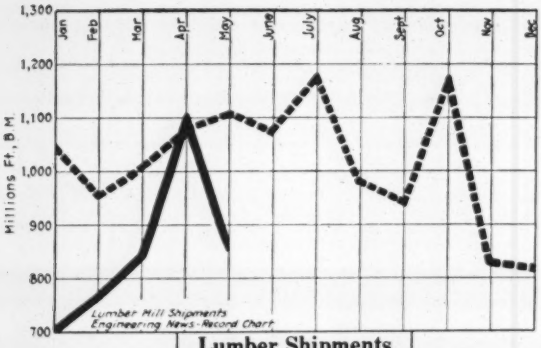
Monthly Statistics of the Construction Industry



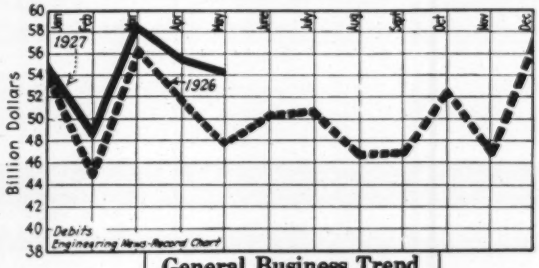
Price of Brick
At Dock, New York



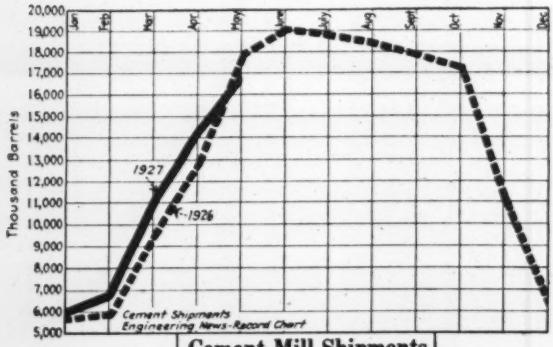
Unfilled Tonnage
On Books of U. S. Steel Corp.



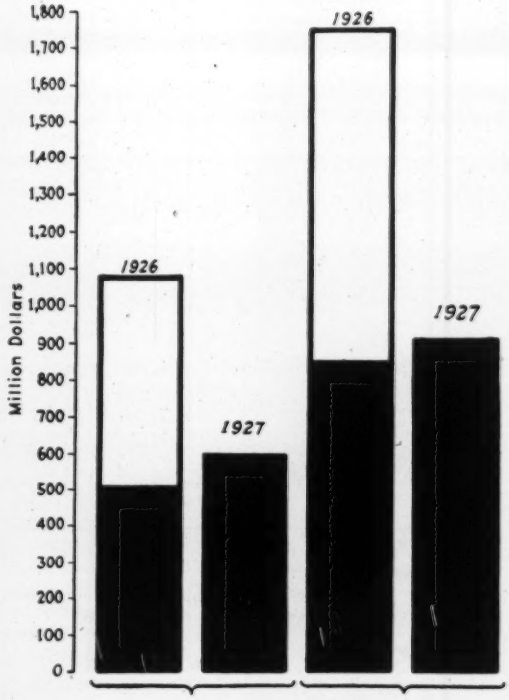
Lumber Shipments
Nat. Lumber Mfrs. Assn.



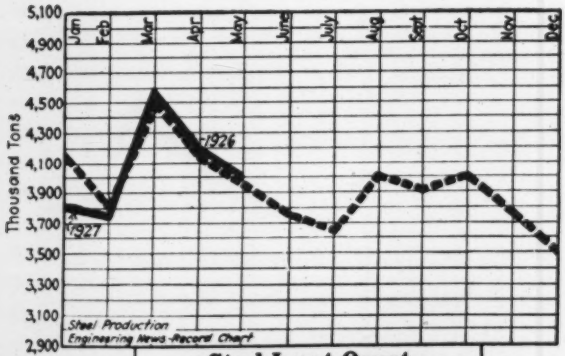
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Shipments
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

Construction Contract Letting Well Ahead of First Half of 1926

Gain Accomplished with Reduction in Cost

THAT the construction industry in the United States is ahead of its record of a year ago is shown by the money spent in awarded contracts for large engineering projects from Jan. 1 to July 1, 1927. Comparisons by sections are shown in the table following.

These figures cover the entire country at a minimum in each class, as follows: waterworks, excavation, drainage, irrigation, levee, river and harbor projects, $15,000; other public works, $25,000; industrial buildings, $40,000; commercial, educational, institutional, religious and other buildings, $150,000. Contract totals are reported each week in this section of the paper, covering lettings up to date of issue.

The average weekly U. S. total for June ran 19 per cent ahead of the same month last year and was barely one per cent under the May, 1927, weekly rate. The cumulative total reveals a gain of 11 per cent for the first half of 1927.

These increases are all the more significant when it is considered that construction costs dropped about one per cent during the last month and are 2 per cent under levels of a year ago. This difference in cost, however slight, converts the increase in money value into a net gain in actual volume.

New York City is evidently moving in a direction contrary to that of the nation as a whole, so far as contract volume is concerned. Awards for the five boroughs, Jan. 1 to June 1, 1927, were over 25 per cent below the corresponding period last year. All classes of construction show decreases except hotels, religious and public buildings, and housing developments.

Danger of over-expansion has been greatest in hotels, office buildings, apartment houses and apartment hotels; see E. N.-R., issue of March 31, 1927, p. 549.

Value of Contracts Awarded by Sections—June, 1927

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Water-works	$1,132,000	$1,136,000	$327,000	$3,325,000	$829,000	$7,196,000	$7,196,000	$30,84,000	$851,000
Sewers	454,000	3,213,000	597,000	3,309,000	1,125,000	2,144,000	10,842,000	55,074,000	207,000
Bridges	657,000	2,959,000	1,345,000	3,111,000	1,446,000	1,603,000	11,121,000	66,011,000	3,545,000
Excavations, drainage, etc	3,027,000	1,263,000	51,000	3,752,000	4,244,000	112,000	12,449,000	29,646,000	258,000
Streets and roads	4,891,000	20,742,000	9,865,000	18,966,000	15,956,000	7,900,000	78,320,000	242,990,000	3,075,000
Industrial buildings	3,441,000	5,757,000	540,000	6,139,000	1,913,000	1,438,000	19,228,000	117,175,000	1,595,000
Commercial buildings	19,292,000	70,222,000	4,317,000	40,769,000	18,533,000	11,480,000	164,612,000	777,742,000	3,746,000
Federal Government	123,000	311,000	674,000	629,000	819,000	455,000	3,011,000	22,661,000	.....
Unclassified	517,000	24,872,000	2,015,000	1,119,000	15,952,000	1,174,000	45,649,000	172,876,000	6,470,000
June, 1927	$33,534,000	$130,474,000	$19,731,000	$81,119,000	$60,817,000	$26,753,000	$352,428,000	$1,514,979,000	$19,747,000
May, 1927	19,268,000	77,056,000	7,352,000	82,547,000	63,239,000	35,818,000	285,280,000	.....	13,619,000
June, 1926	24 260,000	77,073,000	14,402,000	66,626,000	32,078,000	23,186,000	237,625,000	.....	10,434,000
Jan. to date, 1927	120,072,000	463,118,000	103,471,000	379,029,000	268,737,000	180,552,000	1,514,979,000	.....	57,339,000
Jan. 1 to date, 1926	103,199,000	452,836,000	156,540,000	310,477,000	191,096,000	145,859,000	1,360,007,000	.....	62,921,000

Labor Rates and Conditions Throughout the Country

Some Unemployment and Wage Cuts in Building Trades

MORE money is involved in construction contracts placed thus far this year than during the corresponding period of 1926, yet fewer building trades mechanics seem to be required to do the work.

Last year at this time there was no marked recession in employment of this class of labor, while latest reports to *E. N.-R.* reveal over-supply and actual idleness in several important construction centers, namely: Birmingham, Boston, Detroit, Philadelphia, San Francisco, and Seattle.

Notable improvement in the Canadian construction situation, compared with May, has resulted in scarcity of bricklayers and structural ironworkers in the Montreal district and wage adjustments upward in the Ottawa district.

There are not over thirteen strike or wage controversies of major importance, active at the present time; these are briefly outlined in the table on the following page.

The average wage of skilled building trades mechanics, as shown in the graph on p. 37, has remained during the last month at a level approximately 6 per cent above that of a year ago.

Current Building Trades Wage Rates Per Hour

(Higher rates than a month ago indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1 40	$0.70	$0.70	$0.50	.....	$0 75	$0 25@ 30
Baltimore	1 62½@1.75	1 00@1.10	1.00@1 37½	1 00	$0 65	1.00@1.25	40
Birmingham	1 00@1 50	1.05	1 00	50@ 75	.....	1 75	.25@ 40
Boston	1.40	1 25	1 25	79	1 15	1 25	.45@ 74
Cincinnati	1.50	1 35	1 35	.97½	1.35	1.35	.45@.60
Chicago	1 62½	1.10@1.50	1.00@1 50	.90@ 96½	1 50	1 50	90
Cleveland	1.50	1 37½	1.30	.87½	1.10	1 50	.87½
Dallas	1 62½	1 12½	1 00	.40@.75	1.00	1 25	.30@ 50
Denver	1 50@1 62½	1 25	1.25@1 37½	.87½@1 00	.....	1 25	.31¼@ 50
Detroit	1 56¼	1 00@1 25	1 00@1 10	.90	1 00@1 10	1 00@1 25	50@ 60
Kansas City, Mo	1 50	1.25	1.25@1 37½	.90	1 25	1.25	—.35@.75
Los Angeles	1 37½	1.00	1.00	.87½	1.00	1.00	.50
Minneapolis	1.25	.87½@95	.87½@1.00	.75	.....	1 00	.45@ 60
Montreal	1.00@1 25	.75	.75	.40	.50	.85@ 90	30@ 35
New Orleans	1.50	.90	1.00	.75	.80	1 25	.30@ 40
New York	1.75	1 50	1.75	1.12½	1.00@1.12½	1 75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	+1 70	1.50	1.37½@1.50	1.12½	.....	1.50	.80
St. Louis	1.75	1.50	1.50@1 65	1.15@1 25	1 25	1.50	.40@.75
San Francisco	1.37½	1 12½	1 00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1 00@1 12½	1.00	1.00@1.12½	+1.12½@1.25	62½

IMPORTANT ACTIVE STRIKES OR WAGE CONTROVERSIES IN VARIOUS CITIES OF THE U. S.

Location	Craft	Demand
Brooklyn, N. Y.	Painters	$14 per day, an advance of $2.
New York, N. Y.	Union of Technical Men	Increased pay and better working conditions.
Syracuse, N. Y.	Hod carriers and building laborers	85c. per hr., an advance of 15c.
So. Bergen Co., N. J.	Plumbers and helpers	Wage advance.
Newark, N. J.	Building materials truck drivers	Abolition of the open shop
Providence, R. I.	Carpenters	$1.25 per hr., an advance of 15c.
	Common laborers	75c. per hr.
Pawtucket, R.I.	Carpenters	$1.25 per hr., an advance of 15c.
	Hod carriers and laborers	Wage advance.
New Haven, Conn.	Painters and paperhangers	Closed shop.
	Electricians	$9 per day, an advance of $1.
Hartford, Conn.	Structural ironworkers	$12 per day, an advance of $1.
Montreal, Que.	Stone cutters	95c. per hr., an advance of 20c.

PRINCIPAL SETTLEMENTS EFFECTED DURING THE LAST MONTH

Location	Craft	Settlement
Pittsburgh, Pa.	Bricklayers	$13.60 per day, an advance of 60c. and the 5j-day week.
Portland, Ore.	Bricklayers	$11.60 per day, an advance of 60c.
Brooklyn, N. Y.	Plumbers	Negotation of demands for $13.20 per day and 5-day week, against present rate of $12 and 44-hr. week.
Datona Beach, Fla	Brick masons, and plasters	Wage cut of 25c. per hr. to $1.25.
	Carpenters	Wage cut of 35c. per hr. to 90c.
Newark, N. J.	Electricians	$12.50 per day, an advance of 50c.
Somerville and Bound Brook, N. J.	Plumbers	$11 per day, an advance of $1.
Ottawa, Ont.	Carpenters	85c. per hr.
	Masons and bricklayers	$1.20 per hr.

A GREAT many letters have been received since publication of Engineering News-Record CONSTRUCTION COSTS, commenting upon that pamphlet and also upon the regular construction costs division in Engineering News-Record. Numerous suggestions were offered for additions and improvements to the cost section.

These letters are hereby acknowledged and the writers are heartily thanked for their interest and help. Have you a suggestion?

Construction News Editor, Engineering News-Record, Tenth Ave. at 36th St., New York, N. Y.

Monthly Prices of Construction Materials

Declines Continue—Break in Cement at Boston

PRICE declines predominate in a market where the actual physical volume of demand is but a fraction under that of a month ago.

With limited reserve stocks at mills and warehouses throughout the country, in only a few instances is production sufficiently close to current demand, to result in higher quotations than those prevailing last month. Materials showing rises were—re-rolled rails, paving stone, lime, rivets, nails, and steel sheets, at principal producing and distributing centers.

The wide-spread decline of the last month affected mainly four great groups, as follows: pipe—cast-iron (water), soil, and sewer; paving materials—asphalt, curbing, wood blocks and crushed stone; steel—reinforcing bars, structural shapes and plates; paint stuffs—linseed oil, red and white lead. In addition to the foregoing, strong downward tendencies were also noted in scrap, track supplies, ship spikes, boards, timbers, lath, manila rope, tile and brick.

Beneath a sagging steel price structure lies a more than seasonally weak pig-iron market.

The softwood lumber movement is in smaller volume than at this time last year owing principally to recession in small frame building construction; prices tend downward.

OF equal importance with the price movements just mentioned, yet containing possibilities of more serious developments later on, is the present tendency to cut cement prices in the Boston district.

Of the forty-five localities reporting regularly to *Engineering News-Record*, only three show changes compared with June 1 levels, in portland cement. These reports cover principal mill points as well as consuming centers.

Atlanta and Montreal showed advances of 5c. and 86c. per bbl., respectively, while the price at Boston dropped 30c., compared with that of a month ago.

The recession of Boston took place gradually, a final drop of 15c. per bbl. having been declared by the Knickerbocker Portland Cement Co., Inc., a subsidiary of the International Cement Corporation.

The claim persists among manufacturers that foreign cement entering the Boston district in particularly large quantities, is responsible for the abrupt price decline.

Tracing cement mill declines back to the beginning of the year, with relation to Boston imports, it is found that in February, 1927, the month of lightest importations, mill price reductions were most extensive.

The following table shows imports of hydraulic cement for Massachusetts and the entire U. S. during the first four months of 1927:

	Massachusetts, Barrels		United States, Barrels
January	77,721	(Belgium)	193,175
February	26,350	(Belgium)	
	1,500	(United Kingdom)	
	27,850		130,421
March	26,213	(Belgium)	
	5,000	(Norway)	
	1,496	(United Kingdom)	
	32,709		181,145
April	50,432	(Belgium)	191,868
Four months	188,712		696,609

Outstanding mill price declines, thus far in 1927, were as follows: January, Mason City, Ia., 10c. per bbl., compared with the month preceding; February, Hudson, N. Y., 20c. per bbl., Leeds, Ala., and Lehigh Valley District, Pa., each 10c. per bbl., and 5c. at Buffington, Ind., Universal, Pa., Steelton, Minn., Mitchell, Ind., and La Salle, Ill.; April, Hannibal, Mo., 5c. per bbl.

The following tabulation shows shipments from domestic mills into Massachusets and the entire U. S. for the first four month of 1927:

	Massachusetts, Barrels	United States, Barrels
January	70,354	5,894,569
February	81,457	6,682,134
March	193,283	11,017,151
April	293,606	14,296,532
Four months	638,700	37,890,386

It will be seen at a glance that total U. S. imports for the period were not quite 2 per cent of the quantity shipped by domestic markets in the several states. The quantity received from foreign countries by the state of Massachusetts, through the Port of Boston, was approximately 30 per cent of the number of barrels shipped into the same area by American mills, during the period Jan. 1 to May 1, 1927.

The bulk of the Massachusetts imports came from Belgium as shown by the table. This cement, according to latest reports, is sold at approximately $1.91 per bbl., against the current domestic price of $2 per bbl., f.o.b. Boston.

SEVERE price cutting started among Canadian cement manufacturers just a year ago. The price f.o.b. Montreal dropped from $1.42 to $1.15 per bbl. in July, 1926 at which level it remained until June, 1927, and then the market rose to $1.36. During the last month the price has advanced to $2.22 per bbl., f.o.b. siding, Montreal.

This particular process of cutting under was not inspired by importations but was due instead to a rate of production out of proportion to demand.

Canadian construction to date, as measured by contract value, is 10 per cent under the period Jan. 1 to July 1, 1926, while the cumulative total for the U. S. shows a gain of 11 per cent for the first half of 1927, compared with the same months last year. The gain in the latter case was accomplished with a very slight difference in cost, see p. 36.

Cement production for the entire country, now averaging 164,000,000 bbl. yearly, is taking up only about 82 per cent of the total mill capacity of the United States.

Export pressure to the U. S. not only affects cement, but is noticeable in iron, steel, brick, pottery, and glass. At present most of the cement is coming in duty free, from countries not levying against similar materials from the United States.

Million-dollar contracts and over reported this year by *Engineering News-Record* number 135 and amount to $276,648,000. The figures for 1927 and 1926 are as follows:

	1927		1926	
New York	24	$48,663,000	35	$82,066,000
Chicago	27	68,662,000	23	52,748,000
Elsewhere	84	159,323,000	88	157,032,000
To June 15	135	$276,648,000	146	$291,846,000
Average		2,050,000		2,000,000

Next week—Current market prices of materials used in the oil fields.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	July 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$22.19	$24.05
Northern Basic	20.89	24.27
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19	23.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	26.37	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	18.50	21.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	22.76	23.26
Virginia No. 2 (silicon 2.25@2.75)	27.17	28.67
Basic	21.76	22.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	22.50
No. 2 Foundry Southern (silicon 2.25@2.75)	23.55	25.05
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	20.27
Basic	19.76	20.27
Bessemer	21.26	20.27

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	*$11.50@$12.00*	$11.25@$11.75	$11.00@$12.00
Stove plate	**8.50@ 9.75**	12.75@ 13.25	13.00@ 14.00
No. 1 machinery cast	15.00@ 16.00	15.50@ 16.00	15.00@ 16.00
Machine shop turnings	*6.00@ 6.50*	6.00@ 6.50	8.00@ 8.50
Cast borings	*6.75@* 7.50	8.75@ 9.00	8.00@ 8.50
Railroad malleable	*10.75@* 11.25	*12.00@ 12.50*	12.00@ 13.00
Re-rolling rails	*10.50@ 11.25*	13.00@ 13.50	15.00@ 16.00
Re-laying rails	23.00@ 24.00		22.00@ 23.00
Heavy melting steel	*6.75@ 11.35*	10.75@ 11.25	12.00@ 12.25

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	July 7	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	36.00	34@36	34@36	1.80@1.90*	2.05*
Light rails, 12 to 14 lb.	36.00	34@36	34@36	1.80@1.90*	1.88*
Light rails, 25 to 45 lb.	36.00	34@36	34@36	1.80@1.90*	1.84*
Re-rolled rails	**32@34**	28@30		34@36	

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	1.00	1.25
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	July 7	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in.and larger	$2.80	$2.90@3.00	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90	3.90@ 4.15	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	*2.75*	2.75	3.40	3.75	4.00	3.40

Pipe

WROUGHT STEEL AND IRON PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	62	50½	1 to 1¼	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1¼	60	49½	1 to 1½	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36 – 5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier f. o. b. in car load lots:

	Birmingham	Burlington, N. J.	New York July 7	New York One Year Ago
4 in.	*$50.00*	*$48.00*	*$50.60*	$55.60@57.60
6 in. and over	*36.00*	*44.00*	*46.60*	51.60@53.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	*$48.50*	$48.20	*$45.60*	*$53.00*
6 in. and over	*44.50*	44.20	*41.60*	*49.00*

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	July 7	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00		$45.00		$73.00
4	56.00	55.00	$50.00	56.00	$76.50	110.00
5				80.00	97.75	118.00
6	80.00	90.00	85.00	100.00	127.50	150.00
8	150.00	160.00	195.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		$0.072	$0.10		$.088	$0.12	
4		.072	.10	$0.1175	.088	.15	$0.15
5		.099	.135		.121	.18	.18
6	$0.24	.099	.21	.1645	.121	.21	.21
8	.38	.162	.315	.26	.198	.30	.325
10	.50	.2415	.45	.364	.315	.42	.476
12	.66	.3105	.54	.468†	.405	.56	.612
15	1.12†	.414	.75	.78†	.54	.92	1.02
18	1.62†	.575	.90	1.092†	1.00	1.32	1.53
20	1.95†	.69	1.20		1.20		
21		.805	1.25	1.456†	1.40		
22	2.60†	.92	1.35		1.60		1.564
24	2.92†	1.035	2.665	1.872†	1.80	2.16	2.04
27	4.65†	2.08	2.952	2.95†	2.75	3.00	3.34
30	5.16†	2.304	3.96	3.65†	3.75	3.60	4.06
33	6.98†	4.05	4.51	4.45†	4.50		4.99
36	8.00†	4.6125	5.06	4.80†	5.00		5.42

	3	5	8	12	24	36
Boston	*$0.12*	*$0.175*	$0.25	*$0.45*	*$1.80†*	*$5.10†*
Minneapolis			.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	
Seattle	.14		.35	.63	2.52	
Los Angeles	.1675	.186	.2825	.5085†	2.034†	
New Orleans			.205	.40	2.27	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	
Montreal‡		.50	.70	1.50	6.00	
Detroit	.081	.122	.189	.405	2.07†	4.715†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.335	.54†	1.90†	3.80†
Philadelphia	.105	.15	.245	.40	1.40	3.50

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡Freight allowed.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		July 7	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.052	.055
St. Louis, 50@60% asphalt		.0554	.0565
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	
Boston (*Mexican*)	*23.50*	*$19.00*
Chicago (*Texas*)	*23.00*	*18.50*
San Francisco, *f.o.b. refinery*, Oleum, Cal	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)		11.65
Maurer, N. J. (*Bermudez*)	30.00	
Maurer, N. J. (*Trinidad*)	23.00	
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	**28.00**	**23.00**
Los Angeles ("*D*" *grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery. †Turns used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.		$150.00 per M.
San Francisco	Basalt block 4x7x8		70.00 per M.
Chicago		about 5x8x5 dressed	3.60 per sq.yd.
		about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite		**135.00** per M.
Atlanta	Granite		2.50 per sq.yd.
Detroit	5-in. Granite		3.00 per sq.yd.
Blatimore	Granite		2.85 per sq.yd.
Montreal	Granite		104.75 per M.
New Orleans	Granite, 4x8x4		2.75 per sq.yd.
Cincinnati	Granite		135.00 per M.
St. Louis	Granite, 4x8x4		1.65 per sq.yd.
Kansas City	Granite		3.85 per sq.yd.
Philadelphia	Granite		3.90@4.25 per sq.yd.
Minneapolis	Sandstone		2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 90c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., *90c.* per lin.ft., roundings, *$1.55*. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

GOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq. Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	*2.40*
St. Louis	4	16	*2.75*
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, f.o.b., per cu.yd.; weight of sand 1½ tons per cu.yd., gravel, 1½ tons per cu.yd.

	Gravel				Sand	
	1½ In.		¾ In.			
	July 7	One Year Ago	July 7	One Year Ago	July 7	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.00*	1.60	2.00*	1.60	2.00*	1.40
St. Louis	1.45†	1.45†	1.45†	1.45†	1.20†	1.08†
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38*	2.38*	2.38*	2.00*	2.00*
Minneapolis	1.65‡	1.65‡	1.65‡	1.65‡	1.25	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00†
New Orleans	2.10†*	2.60†*	2.60†*	2.60†*	1.80†	1.80†
Los Angeles	2.00†*	1.15†	2.00†*	1.15†	1.40†	.90‡†
Atlanta	**2.20**†	1.90†	**2.20**†	1.90†	*1.40*†	1.50†
Detroit	1.70	1.45	1.60	1.35	1.35	1.10
Baltimore	1.40	1.40	1.60	1.60	.70‡†	.70‡†
Montreal	1.90†	1.25†	1.50†	1.35†	1.35†	1.25†
Birmingham	2.00*	2.00*	2.00*	2.00*	1.50	1.50
Philadelphia	2.25*	2.10*	2.25*	2.10*	1.65	1.50
Kansas City, Mo.	....	....	....	....	.66‡†	.66‡†
Pittsburgh	.85‡	....	.85‡	....	1.25	....

*Delivered †Per ton. ‡At pit.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd., f.o.b. cars as follows:

	1½ In.		¾ In.	
	July 7	One Year Ago	July 7	One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	2.00†	1.70	2.00†	1.87½
St. Louis	1.83*	1.83*	1.83†	1.93*
Dallas	2.40†	2.40†	2.83†	2.83†
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	*2.00**	1.60*	*2.00**	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	*1.75*	2.00	*1.75*	2.00
Denver	2.50†	2.50†	2.50†	2.50†
Seattle	3.00†	3.00†	3.00†	3.00†
Atlanta	2.50*†	2.50*†	2.50*†	2.50*†
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	2.00*†	1.40*	2.00*†	1.40*
Detroit	2.60*†	2.00*†	2.60*†	2.00*†
Baltimore	2.50†	2.50†	2.55†	2.55†
Montreal	1.80*	1.80*	2.00*†	1.70*
Philadelphia	2.25†	2.10†	2.25†	2.10†
Pittsburgh	2.75†	2.85†	2.75†	2.85†
Cleveland	2.70*†	2.70*†	2.70*†	2.70*†
Birmingham	2.00†	2.00†	2.00†	2.00†

* Per ton. † Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	....	1.40
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	....	1.50†
St. Louis	23.50	17.50	....	2.03*
Boston	18.25	11.00	3.50*	2.10@3.00*
Dallas	19.00	....	....	1.82‡
Cincinnati	16.80	11.90	....	11.40‡
San Francisco	27.50	24.00	....	1.70†
Minneapolis	25.50	21.00	....	1.70†
Denver	24.00	....	....	2.70*
Detroit	15.50	11.50	....	12.00‡
Seattle, *paper sacks*	24.00	....	2.80†	....
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	17.85	2.55†	....
Montreal	....	21.00	....	10.00‡
Atlanta	**24.50**	**13.50**	....	1.50†
New Orleans	24.00	15.00	2.60†	2.50*
Philadelphia	23.00	15.00	....	....
Kansas City	17.50	**15.50**	2.65†	2.50*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	July 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.45**	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	*2.00*	2.60
St. Louis (Carney)	2.75	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	July 7	One Month Ago	One Year Ago
New York, del. by truck	$2.35@$2.50	$2.35@$2.50	$2.50@$2.60
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.13	2.13	2.33
Boston	*2.00*	2.30	2.35
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.15	2.15	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	2.51	2.51	2.31
New Orleans	2.40	2.40	2.30
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	**2.40**	2.35	2.35
Cincinnati	2.32	2.32	2.37
Los Angeles	2.56	2.56	2.30
Baltimore	2.50	2.50	2.35
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.10	2.10	2.35
Montreal	**2.22**	1.36	1.15
Philadelphia	2.40	2.40	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.85
Steelton, Minn.	1.85	Hannibal, Mo.	1.90
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	1.90
Iola, Kan.	1.85	Alpena, Mich.	1.75
Mason City, Ia.	1.80	Kingsport, Tenn.	2.05
La Salle, Ill.	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	.....	1.14	1.02	.....
067R	31	1.35	1.38	.....	1.45	1.39	.....
089R	40	1.74	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19.50	$17.50	$16.50	*$17.00*	$24.00
2.5	18.50	21.50	18.50	17.50	*19.00*	26.00
3.0	21.00	24.50	21.00	20.00	*22.00*	29.00
3.4	22.50	27.50	22.50	21.50	*24.00*	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger	*$1.75@* $1.90	$2.00	$3.24	$2.30@$2.50	$3.15	$2.75	$2.95
⅜	*1.85@* 2.00	2.10	3.34	2.40@ 2.60	3.25	2.85	3.05
½	*1.95@* 2.10	2.20	3.44	2.50@ 2.70	3.35	2.95	3.15
⅝	*2.15@* 2.30	2.40	3.64	2.70@ 2.90	3.55	3.10	3.35
¾	*2.75@* 2.90	3.00	4.24	3.30@ 3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
¾ in and larger	$2.25	$2.48	⅞	#2.65	$2.88
⅞	2.35	2.58	1	3.25	3.48
1	2.45	2.68			

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: July 7	Common: One Month Ago	Common: One Year Ago	Paving Brick: 3-inch*	Paving Brick: 3½-inch*
New York (del.)	*$17@*19	$19@20	$20.40	$45.00†	$51.00†
New York (at dock)	*14@* 16	16@17	17.00		
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	12.00	.....	.....
Dallas	*13.60*	14.10	14.10	35.00	.....
San Francisco	14.00	14.00	15.00	.....	.....
Los Angeles	10.00	10.00	9.00	(not used)	
Boston (del.)	20.00	20.00	18.50	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.75	.....	.....
Kansas City	*14.00*	14.50	15.00	(no market)	
Seattle	14.00	14.00	15.00	.....	55.00
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	20.25	20.25	17.50	100.00‡	.....
Detroit (del.)	14.00	14.00	16.00	38.40	41.50
Baltimore	*18.00*	19.00	18.00	40.00	45.00
Atlanta	12.50	12.00	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	18.00	18.00	17@19	40.00	50.00
Pittsburgh (del.)	*17.00*	17@18	16.00	.....	.....
Cleveland	14@16	14@16	16.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: July 7 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1027	$0.1112	$0.076	$.011	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	.....
8x12x12	.1926	.2084	.142	.21	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.2388
12x12x12	.....	.....	.202	.32	.186	.....	.2956

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.15	$0.25
Minneapolis (f.o.b. cars)	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.154	.252
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.11	.205	.31
Detroit	.0707	.1326	.1853
Montreal	.10	....	.....
Baltimore	.124	.268	.....
Atlanta	*.072½*	*.1358*	.....
Dallas	*.103*	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.07	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	*$1.70@$1.85*	$1.90@$2.00	$3.34	*4.00*	$3.25	$3.10	$3.10
Channels, 3 to 15 in.	*1.70@ 1.85*	1.90@ 2.00	3.34	*4.00*	3.25	3.10	3.10
Angles, 3 to 16 in., ¼ in. thick	*1.70@ 1.85*	1.90@ 2.00	3.34	*4.00*	3.25	3.10	3.10
Tees, 3 in. and larger	*1.70@ 1.85*	1.90@ 2.00	3.34	*4.00*	3.35	3.10	3.10
Plates, ¼ in. thick and heavier	*1.75@ 1.85*	1.90@ 2.00	3.34	*4.00*	3.25	3.10	3.10

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	New York: July 7	New York: One Yr. Ago	Warehouse: Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.75@$3.00	$5.00	$4.50	$3.50	$3.75	$5.00	$4.75
		CONE HEAD BOILER					
½ in.	$2.90@$3.15	.....	$4.70	$3.70	$3.90	$5.50	$5.00
⅝ and ¾	3.05@ 3.30	.....	4.85	3.80	4.15	5.65	5.15
⅞ and 1	3.30@ 3.55	.....	5.10	4.05	4.40	5.85	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	*$2.50*	$2.85	$2.95	$3.45	$4.25	$2.83	$4.95
Cut	2.80	2.90	.....	5.00	5.00	2.93	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, *$3.15@3.25*.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93½ per 100 lb. to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt per 100 lb	$3.25
Asphalt coating, per gal	.33
Asphalt felt, per 100 lb	3.40

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.25	$3.60	$3.50	$3.85	$3.89
No. 12	2.30	3.65	3.55	3.90	3.94
No. 14	2.35	3.70	3.60	3.95	3.99
No. 16	2.45	3.80	3.70	4.05	4.09
Black					
Nos. 18 to 20	2.80	4.30	3.75	4.70	4.00
No. 22	2.95	4.45	3.90	4.85	4.15
No. 24	3.00	4.50	3.95	4.90	4.20
No. 26	3.10	4.60	4.05	5.00	4.30
No. 28	3.25	4.75	4.20	5.15	4.45
Galvanized					
No. 10	3.15	4.65	4.10	.....	4.25
Nos. 12 to 14	3.25	4.75	4.20	4.85	4.35
No. 16	3.35	4.85	4.30	4.95	4.45
No. 18	3.50	5.00	4.45	5.10	4.60
No. 20	3.65	5.15	4.60	5.25	4.75
No. 22	3.70	5.20	4.65	5.30	4.80
No. 24	3.85	5.35	4.80	5.45	4.95
No. 26	4.05	5.60	5.05	5.70	5.20
No. 28	4.30	5.85	5.30	5.95	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: June 7	New York: One Year Ago	Chicago: July 7	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	*$0.87*	$0.89½	*$0.87*	$0.94

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	July 7	1 Yr. Ago	July 7	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No.1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$40.00@$42.00	$41.00@$43.00	$38.00	$40.50
3x10 to 10x10	47.00@ 49.00	48.00@ 50.00	45.00	40.50
3x12 to 12x12	54.00@ 56.00	55.00@ 57.00	54.00	40.50
3x14 to 14x14	62.00@ 64.00	63.00@ 65.00	.....	40.50
3x16 to 16x16	74.00@ 76.00	75.00@ 77.00	.....	42.00

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.00	$47.50†	$50.00	$52.00	$58.00	$57.50†
Seattle	.....	24.00	.....	.....	.....	23.00
New Orleans	36.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	.....	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	.....	.....	60.00	50.00
Los Angeles	.....	32.00	.....	.....	.....	32.00
Denver	.....	33.25	34.25	34.25	.....	34.25
Minneapolis	42.50	38.75	34.50	.....	47.00	39.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	42.50	38.75	.....	.....	56.50	42.50
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	48.00	36.00	38.00	45.00	62.00	36.00
Detroit	46.00	42.50	.....	.....	58.00	42.00
St. Louis	41.00	.....	.....	.....	53.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$44.00	$43.00†	$45.00	$49.00	$48.00†
Seattle	.....	22.00	.....	.....	23.50
New Orleans	38.00	46.00	.....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles	.....	24.50	.....	.....	36.00
Denver	.....	32.25	33.25	.....	32.75
Minneapolis	40.50	36.25	34.75	35.50	35.00
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	48.25	35.75	.....	48.75	42.25
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	30.00	36.00	36.00	52.00	36.00
Detroit	40.50	37.00	.....	44.00	41.25
St. Louis	43.00	.....	.....	28.00	.....

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

July 7	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	....	Minneapolis	.14*
New York (Brooklyn)	.18@.20	Philadelphia	.18@.20
Pittsburgh	.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8 ft.; ½-in., 6; ⅝-in., 4½; ¾-in., 3½; 1-in., 2½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.24	New Orleans	$0.21
New York	.24½	Los Angeles	.25
Chicago	.23	Seattle	.23
Minneapolis	.25	St. Louis	.23
San Francisco	.22½	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	.25@.26	Baltimore	.18
Cincinnati	.21	Kansas City	.25
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.23	.25
Kansas City	.215	.235
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.20	.22½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500 lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	4.95@5.00
Soda ash, 58%, in bags, per 100 lb.	1.32½@1.37½
Chlorine, liquid, cylinders, per lb.	.05½@.08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

*Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.